Gulstonian Lectures

ON

FEVER & INFLAMMATION.

DELIVERED

BEFORE THE PRESIDENT & FELLOWS OF THE ROYAL COLLEGE OF PHYSICIANS, LONDON, 1859.

BY

WILLIAM ADDISON, M.D., F.R.S., F.L.S.,

FELLOW OF THE COLLEGE.

[*Reprinted from the* BRITISH MEDICAL JOURNAL.]

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FEVER AND INFLAMMATION.

LECTURE I.

Mr. President and Gentlemen,—If we carefully examine into the causes which produce disease, it will be found that, in a great majority of instances, they may be resolved into some violation or neglect of the natural laws upon which the healthy actions of the animal frame depend. So also, on the other hand, the means of cure in such cases will be found to consist in aiding and adjusting natural efforts to reestablish those laws and conditions which have been outraged or infringed. Let us observe what these natural efforts are.

In the repair of injuries to the human body, certain parts are healed by the growth or production of elements identical with those of the wounded texture. On the other hand, there are organs, injuries to which are repaired, not by the growth of elements identical with those composing the injured organ, but by elements of the same kind with those which are effectual for cure in the former cases. The result is that, in all examples, and in very different parts of the body, the elements of repair appear to have a common form or nature. Now, the parts which are restored by the production of elements identical with those composing the injured texture, are such as have the most general distribution in the body, and are ministering to the purposes of life in the lowliest or simplest manner.

For example:—Fibrous and connective tissues and blood-vessels are everywhere present; no part of the body can be said to be without them; all these are speedily reproduced or repaired when injured or broken. Tendons, ligaments, and bones, are of very general distribution: these also are repaired by new growths of tendinous and osseous tissues. But when we come to investigate the healing process in more special organs, it assumes a different aspect. For, if a portion of the

muscular flesh be rent away by an accident, cure is effected, not by the growth of new muscular fibres, but by a growth of common fibrous tissue. So likewise, if a part of the lung, of the brain, or of the liver or kidney, be destroyed by accident or disease, cure, if effected in these instances, is so, not by a growth of the special parenchyma, but by a common fibrous tissue.

Upon this ground, then—namely, the common form of elements of repair—we purpose to review the human body as a structure composed of three orders or classes of parts: a common tissue; the blood; and parenchymatous organs.

I.—A Common Tissue: its several Forms and Uses.

The areolar tissue is a common tissue diffused throughout the whole body. It invests the exterior, and enters with the blood-vessels into the interior of every organ. Its elements everywhere incorporate with the coats of the vessels. And in all fibrous membranes the elements of the membranous tissue between the blood-vessels are of the same kind with those forming the coats of the vessels.

In natural growth, in the embryo, areolar tissue is at first composed of cells and nuclei; and the coats of the blood-vessels, and those parts of the body which are hereafter to become tendons, ligaments, and bones, consist in the embryo of cells and nuclei also. As growth proceeds, the areolar tissue becomes fibrous; and, *pari passu* with it, the coats of the blood-vessels, tendons, and membranes generally, become fibrous. When growth has been completed, nuclei are found incorporated with the fibres in fibrous membranes, in the coats of the blood-vessels, in capillaries, in periosteum, and also intermingled with the elements of bone. Fibrous membranes and areolar tissue are modelled to the subdivisions of the organ they invest; and bones mould themselves to the soft parts they enclose. If the brain be monstrous at birth, the fibrous membranes and bones investing the organ are monstrous also.

In animals where the hair is particoloured, the fibrous tissue of the skin is patched in corresponding lighter and darker shades; and in such cases we have observed the pia mater patched in similar shades, the pigment being incorporated in the coats of all the small blood-vessels. In some birds of dark plumage, the periosteum is almost black, the tendons are tinged with black, and the coats of the blood-vessels are spotted black.

We have said that the elements of repair have a common form. In the human body, all mechanical injuries, wounds, and fractures, are cured by a common granulation and fibrous

tissue, which pass through the same phases of growth as the original connective tissue and blood-vessels in the embryo.

From pathological anatomy we know that plates of osseous tissue are often found incorporated in fibrous tissues, and also in the coats of the blood-vessels; nay, they sometimes hang loose in the form of *phlebolites* in their interior. In five instances of phlebolites examined by Dr. John Reid of Edinburgh, and in others observed by Dr. G. Burrows, Tiedemann, Otto, Carswell, etc., they were attached to the inner coat of the veins by thin fibrous cords. Dr. Reid describes them as hard as bone; two of them were analysed and found to consist of phosphate of lime, carbonate of lime, and animal matter in proportions similar to those existing in bone.

In some experiments recently published, it was found that the periosteum, when separated carefully from a bone and wrapped round a portion of the muscular flesh in a living animal, continued to generate or secrete bone around the muscle, as it would have done around the bone had its removal from it not taken place. And generally all fibrous tissues, both those of original and those of reparative growth, are disposed to, and do very frequently, take on a change to bone or osseous tissue.

These are the grounds upon which we argue a common nature or a common element in the blood-vessels, and in the fibrous and osseous tissues. Periosteum, pericardium, dura mater, pia mater, the coats of the blood-vessels, areolar tissue, tendons, ligaments, and bones,—all these we propose to comprehend under the designation Common Tissue, because they are all reparable by the production of conformable elements. They have a common mode of growth; and are all subordinate tissues—connective, blood-distributing, and supporting tissues.

Objections, no doubt, can be raised against this comprehensive classification; but we shall endeavour to substantiate its propriety by numerous facts; and, when particulars are properly placed in harmony, they become united and form a class, which, if appropriate, may suggest laws fitted to form elements of higher inductions.

Blood, as it circulates in the living body, consists of a colourless fluid; and swimming in it are the red corpuscles. When withdrawn from the body by venesection, blood soon coagulates, forming an uniform soft solid, which is commonly of a deep red colour throughout. There are many occasions, however, where blood before coagulation separates into two parts; the uppermost fluid and colourless, the lower red. The former part, termed lymph, plasma, or liquor sanguinis, forms on coagulation a tough, white, fibrous clot, or tissue; the latter part contains the red corpuscles, and forms a much more loose or friable mass. This spontaneous separation of blood whilst

still fluid into two parts, viz., the colourless element or plasma, and the red corpuscles, warrants the distinction we shall preserve and enforce between the fluid or plasma and the red corpuscles.

II.—Relations of the Common Tissue to the Fluid or Plasma of the Blood in Natural Growth, and in the Process of Repair, as observed in Common Injuries.

The human embryo is a body which, in a brief space of time, grows from a microscopic mass of colourless cells into a complex structure composed, with other things, of numerous forms of fibrous tissue, blood-vessels, tendons, ligaments, and bones. At this time, the blood abounds most profusely in colourless or plasma elements. During pregnancy, the placenta, a mass of common tissue, and the blood-vessels of the uterus, are in active growth; and the blood of the pregnant woman abounds in colourless elements. On viewing the circulation of the blood in a living animal, if the part under observation be roughly handled or irritated, the colourless or plasma elements of the blood may be seen lingering upon or adhering to the coats of the vessels; whereas no such attraction is seen between the coats of the vessels and the red corpuscles. The ordinary process of repair involves new growth of blood-vessels and fibrous tissue; and, if blood be drawn from within the sphere of the action, it is found to be highly charged with colourless or plasma elements. The inference from these facts is, that the plasma or colourless elements of blood furnish material for the growth of the common tissue.

But what are the proverbial effects of common injuries? and with what phenomena is their healing or cure accomplished?

If a part of the body be scalded, it speedily becomes red, and a colourless fluid is effused beneath the epidermis; after a short time, the sore or wound heals spontaneously. In burns, the object inflicting injury is higher in temperature; its influence extends more deeply; a portion of the skin is killed. At first, the dead part adheres firmly to the living parts beneath; but afterwards, when a discharge of pus appears, it loosens, and may be easily taken away as a slough, without pain or bleeding.

Case. A young lady with fever had been in bed fourteen days; and a slough formed on the lower part of the back. When first examined, it was black and dry; it adhered very strongly to the parts beneath, and any attempt at its removal would have caused pain and bleeding. But, a few days afterwards, when a discharge of pus appeared, the slough gradually became loosened, and then peeled off spontaneously, without pain or bleeding.

In all cases, the detachment of a slough without bleeding is consequent upon the appearance of the purulent discharge; and when it has falleu off, a new tissue, termed granulations, comes into view. These consist of new blood-vessels traversing embryoniform elements; and they follow the same course of growth as the common counective or blood-distributing tissue in the embryo. Granulations change into fibrous tissue for the reparation of fibrous tissue, and into bone for the repair of bone.

But, before a slough can thus fall off, there must have been a severance of the blood-vessels and other bonds of connexion which previously united the dead with the living parts. This severauce is accomplished by granulations and pus, without any bleeding. And, as the new vessels of the granulations carry on the circulation of the blood, so therefore there is positive proof that the older vessels must have been opened for communication with the new ones by alteration and absorption of their coats, without any loss of blood.

When a thorn has entered the flesh, if it be not speedily removed or taken out, abscess and ulceration appear in the parts around; and thus the offending body is loosened and discharged. The action thus set up will go on until the foreign body be cast out; whereupon the parts return to their natural state spontaneonsly.

Case. A forgeman was struck in the eye by a small particle of iron, which remained impacted in the cornea. He had been suffering from the accident for three or four days. The eye was red, from preternatural vascular action; and through a lens the wound in the cornea was seen filled with pus, the particle of iron still sticking in the middle of the sore. Abscess and ulceration had taken place in the tissue in contact with the foreign body. And that they formed part of the natural effort to loosen and cast out the injurious substance, may be presumed; because, upon the removal of it by surgical means, abscess and ulceration ceased spontaneously, and the eye in a very speedy manner was restored to its natural state, without any further extraneous aid.

If the ends of a fractured bone be examined between the first and tenth day after the injury, the periosteum and medullary membrane are found torn; the neighbouring soft parts swollen; and blood is effused between the fragments. The periosteum and medullary membrane have, both of them, lost their fibrous character at the place of fracture; both have become the seat of a mass of granulations, which grow in the form of rosy points, and unite, interlacing with one another, so that the fractured ends of the bone are surrounded on all sides by granulations. From the tenth to the twentieth day, the granulations assume a firmer and more fibrous character; they are converted into fibrous tissue. Between the twentieth and the

sixtieth day, according to the age and constitution of the patient, the fibrous tissue becomes converted into a spongy, and finally into a compact osseous tissue.

The liver or kidney is sometimes the seat of a parasitical creature termed *acephalocyst.* In such cases, abscess and ulceration may take place in the surrounding tissue; and it is worthy of note to observe the outlet of the contents of the abscess frequently barred in all the most dangerous directions by a thickening and strengthening of the fibrous tissues, whilst, at the same time, in some safer point of the circle, the overlying tissues are thinned away by absorption. Likewise in the lung, if an abscess, the result of softening tubercles, be near to the surface of the organ, and therefore likely to discharge its contents into the cavity of the chest, the accident is provided against. Adhesions form between the wall of the chest and the lung. Fibrous connective tissue grows abundantly upon the threatened spot, whereby the escape of matter from the abscess in that dangerous direction is very often prevented.

When a blood-vessel has given way in the brain, a clot is formed, and the contiguous parts are softened by a species of abscess. If all other circumstances are favourable to recovery, reparation in a great degree is effected, even in these cases. The walls of the abscess change into common fibrous tissue; absorption of all the fluid part of the clot ensues; and the new fibrous tissue fills the space which may have been occasioned by any spoiled or lost portion of the brain-parenchyma.

In small-pox, numerous pustules or abscesses appear in the skin. With the full growth of the pustules, the fever declines.

In all these examples, granulations and pus—abscess and ulceration—are established for the avoidance of greater dangers, for the purpose of throwing off dead and injurious matter from the living body. Nor can we doubt that the purulent discharge in such cases performs an office in the series of events as useful and necessary as the granulations. Granulations and pus are both of them forms of primitive or embryoniform cell growth. Granulations are the basis of the new repairing texture: they are traversed by numerous new blood-vessels; and they change, as before said, into fibrous tissue where fibrous tissue is needed for cure; and this again changes into bone where bone is needed, as it is for the cure of a fractured bone. Pus, on the other hand, is incoherent, and seems by this special quality to be fitly an agent in the separation of sloughs, and in the discharge of other injurious matters from the body. The particles of pus are colourless, and granulations are red only by reason of the number of new blood-vessels which traverse them; for, when granulations are altering into fibrous tissue, the number of blood-vessels greatly diminishes; and then the texture resumes its natural or proper

hue, which is colourless or white. Abscess and ulceratiou are terms which comprise the effects produced upon the older tissue by the growth of the new one; namely, the loss and absorption it undergoes.

Let us briefly recapitulate the facts, and state our conclusions.

At early periods of natural growth, and in pregnant women where the placenta is growiug, the blood *generally*, and, within the sphere of new growth for purposes of reparatiou, the blood *locally*, is highly charged with colourless or plasma elements. The fluid which exudes from the blood-vessels upon slight injuries—scalds, blisters, and scratches—scarcely differs at all from the plasma. The elements of granulations and pus are colourless, and hardly to be distiuguished from the colourless corpuscular elements of the plasma which may be seen in some animals adhering to and accumulating upon the inside of the coats of vessels which have been irritated or wounded.

"The elements of exudations", says Rokitansky, "are fouud preformed within the vessels; and the character of the subsequent products is thus shown to be dependent upon inbred trausformations of the blood, and more particularly of its plasma." Or as we, in somewhat different words, gave expression to the same fact many years ago, "Colourless corpuscular elements of the blood accumulate upon the coats of irritated or injured blood-vessels, and thereby change their character; and from the altered vessels issues the new product, both in repair and inflammation."

Our conclusion is, that a commou connective blood-distributing tissue is diffused throughout the whole body; that blood-vessels, fibrous tissues, and bones, are forms of this tissue; and that, in all cases of injury—wounds and fractures—cure is accomplished by new productions of this tissue, the materials of which are derived from the fluid of the blood.

There is, then, a more intimate relation between the fluid of the blood and its containing vessels, than between them and the corpuscles of the blood. And blood-vessels are quickly repaired and reproduced, because their coats are constructed of elements of the plasma—elements which readily corpusculate and fibrillate.

A slough of the skin or outer integument is thrown off easily, without bleeding. In such cases, we presume, therapeutical reactions, comprising suppuration, ulceration, granulation, and purulent discharge, are observed under the best circumstances.

In carbuncle, the dead tissue lies beneath the living skin. The process of separation is therefore protracted until a free outlet has been made either by the natural efforts, or by the knife of the surgeon. In common issues, granulation and suppuration may be almost indefinitely protracted by keeping

peas in the sore. In necrosis of bone, the dead bone lies beneath the living skin; nay, sometimes it is included within a shell of new grown bone. In all these cases, granulation, suppuration, and ulceration, are protracted or chronic. The protraction, however, is not chargeable upon any pathological action; the action is physiological, tending to repair; but success is hindered by physical difficulties, as in the following example.

Case. George S., aged 18 years, was admitted into the Sussex County Hospital on April 1st, 1857, under the care of Mr. Lowdell. He had suffered for four years from necrosis of the tibia. Portions of dead bone had from time to time been removed; but no great benefit had resulted. He had now two fistulous openings—one at the upper end of the bone, the other close to the inner ankle—through both of which dead bone could be felt. The intermediate portion of the leg presented that chronic thickening and inflammation of the skin which usually arise from long continued disease. He was anxious to undergo any operation; for the continually repeated attacks of inflammation impaired his health, and rendered him unfit for any work.

Chloroform was administered; and an incision was made along the front of the upper part of the tibia, so as to include the upper opening, and penetrate to the bone. Dead bone could now be seen; but the opening through the new bone was so small that it required enlargement before any portion of the sequestrum could be taken hold of.

"I now found", says Mr. Lowdell, "that the dead bone reached downwards the whole length of the tibia; and then began the physical force part of the operation—the trephining, chiselling, and gouging through new bone, so hard and thick that the proceedings were more like those on a carpenter's table than operating on the human subject. The opening made in this man's tibia was eight or nine inches in length, more than an inch in depth, before all the dead bone could be removed."

The recovery was complete and satisfactory. In a few days after the operation, the surface of the bone was covered with granulations; new integument formed; and in less than three months the patient was discharged cured. His leg was, in June 1858, as strong as the other.

In this case, it is demonstrated, as much as anything of the kind can be, that the action which had been going on for years, and which contributed to weaken and disable the patient, was not a diseased action, in any proper sense of the terms. On the contrary, it comprised the resistance opposed by the living tissues to the decomposition of the dead bone.

The fistulous openings were outlets for the discharge of spoiled and offending matter, necessary so long as the dead

bone remained: and, because the reactions cannot effect the expulsion of dead bone in diseased joints and other cases, we have no warrant, therefore, without heed of the surrounding circumstances, to invest them with an exclusively pathological meaning. Therapeutical reactions (as in the case related), when opposed by insurmountable difficulties, may contribute to weaken and undermine the health of the person; but without them a decline of the life of the patient would be the more rapid, because the decompositiou of the dead bone would, in such case, be speedily communicated to the contiguous tissues. In all severe injuries—compound fractures, crushed joints, contusions, and lacerations—inflammation, suppuration, granulation, and purulent discharge, must be regarded as phenomena of therapeutical reaction, notwithstanding that, from the severity of the accident or other causes, the health and life of the patient may be endangered in their progress.

It follows, then, that forms of inflammation, granulation, pus, suppuration, and ulceration, are ordinary phenomena of therapeutical reaction in injuries and disease of the common tissue. The action is between the blood-vessels and the plasma or fluid of the blood; and protraction or chronicity, or even danger to life from physical hindrances, does not impugn the idea or exclude the conception of a process established for reparation, though it should fail.

In the examples we have particularised, the common tissue takes the initiative, as it does in all mechanical injuries. Let us, then, now proceed to speak of the other element—the other moiety, as it were—of the action; namely, the fluid or plasma of the blood.

III.—The Fluid or Plasma of the Blood.

The plasma is a very complicated fluid. Its chief constituents are water, fibrine, albumen, colourless corpuscles, volatile matter, fatty compounds, and salts. In its passage through the capillary vessels it permeates all organs and tissues; and, at various points of the circulation, the parenchymatous depurating organs remove from it those substances, which, if retained in it, would injure its qualities. We find that numerous soluble compounds—substances, for instance, which have been taken as food or drink, and poisons received into the stomach—are absorbed into the plasma, whence they may be again eliminated or removed, changed or unchanged by the depurating organs—the organs of secretion.

Many of the common poisons have a local action as irritants, and also a remote or special action upon some parenchymatous organs; other poisons exhibit only the remote or special action. Cantharides has a special action as an irritant to the stomach; it also affects, remotely, through the plasma, the urinary organs.

Morphia, taken by the stomaeh, affects speeially the brain, through the plasma. Digitalis, taken by the stomaeh, affeets the heart; stryehnia the spinal marrow, through the same medium.

In experiments on animals with prussie aeid, it has heen found when death took place within a few miuutes only, that the odour of the poison eould be perceived iu the eavities of the body; and again in other experiments, where preparations of autimony were injected into the hlood by a vein iu the thigh, the metal has been found in the eoats of the stomach.

From these and numerous other faets, which it is unuecessary to particularise, we learn that poisonous suhstances, taken hy the stomaeh, enter the plasma or mingle with the fluid of the hlood; and therehy the poisouing, not of all, hut of some one pareuehymatous orgau eusues, determiued by the nature of the poison, and the special qualities of the parenehymatous elements of the differont orgaus. But, if we compare the actions of these common poisons reeeived iuto tho body through the stomach, with the action of aërial poisons inhaled by the lungs, importaut differenees will be found. In the former, the symptoms do not hegin with fever, nor is any eontagious matter generated in the blood; whereas both these phenomena are distinguishing features of the latter. Here, then, we have a ground for our argument, that the two parts of the hlood have distinet pathological relations; for poisons taken hy the stomaeh exhibit themselves hy symptoms whieh proeeed from some local parenehymatous organ, and they do not eause the produetion of a contagious matter in the blood; whereas poisons inhaled from the atmosphere by the lungs very often do so. Yet hoth species or classes of poisons act through the medium of the hlood.

In 1832, numerous eases of cholera, then epidemie, were treated hy saline injeetions, thrown into the hlood in large quantities, not only without hurt to the patient, but in some instances with great apparent henefit. Among mauy others, there is a very remarkable ease reported in the *Lancet* (vol. ii, 1831 and 1832), in which five gallons of saline liquid were injeeted by a vein, in four days.

The first injeetion was to the amount of ninc pounds and a half; it was thrown into the eireulation iu the spaee of eighteen minutes. A few hours afterwards an additional teu pounds of the saline fluid were injeeted, with four ounees of albumen. This was at one of the clock on the morning of the 29th May; at half past seven the samc morning the injectiou was repeated to the amouut of ten pounds, with the addition of ten graius of sulphate of quinine; at half-past eleven the injection was repeated to the amount of ten pounds. On the second of Juue, at half-past four in the morning, six pouuds aud a half of the saline fluid were injeeted, with six drops of a solution of mor-

phia; and on the 19th of June the patient is reported to have left the hospital, well.

If we look around, we may see in all classes of society individuals of various conditions of body. We may contrast the florid complexion with the pale thin face; tissues laden with fat with the spare habit; those who luxuriate in good living with those existing on bread, potatoes, and water. Persons in each of these classes may be following their daily avocations in good health, yet the blood-fluid, we know, cannot be the same in all of them; nor can it be the same or have the same qualities in the same person, if he greatly alter his diet, his food and drink. In the chemistry of the blood, there are scarcely two analyses of it alike; and the milky serum sometimes seen in blood after venesection has been referred to articles of diet, or to the recency of a meal, which has for a time changed the qualities of the plasma.

These facts support or coincide with our argument that the blood must be regarded in respect to its pathology, as consisting of two distinct parts; and of these, that the plasma, or fluid, holds a position of different or inferior rank to the red corpuscles in the functions of life. It furnishes elements of growth and reparation to its containing vessels, the common tissue; and it is the medium in which the corpuscles swim; but it varies, within certain limits, in qualities and composition, from day to day, according to the nature and abundance of the food and drink; nay, further, it appears that it may vary, in quality and composition, from poisonous substances taken into the stomach, so as to occasion symptoms of poisoning in some local parenchymatous organ, before any of the symptoms of fever appear, and without evidence of the generation of any contagious matter in the blood.

IV.—Distemperatures or Dyscrasies of the Plasma or Fluid of the Blood.

There are varieties or changes of health—moods, tempers, and feelings—dependent upon qualities of blood which are temporary, multifarious, and fleeting. They are cured by attention to diet and the excretions; by good living in those who have fared badly, or are half starved; by abstinence and physic in those who have abused the good things of the table. These changes in the moods and feelings of the individual, have all the characters of dependence upon that part of the blood which is quickly replenished and altered by diet—namely, the plasma.

Also there are numerous forms of inflammation which are uncertain and multifarious—dependent upon qualities of blood occasioned by unwholesomeness of diet, privations, and neglect of the functions of the depurating organs—the skin, kidneys, and bowels. Sometimes the simplest wounds fester and

ulcerate. Eruptions, pustules, or boils break out in the skin; or the slightest external injury provokes chronic and ulcerative forms of inflammation without fever, comprehended in the terms scrofula and scurvy. For example:—

Sailors at sea are dieted on salt provisions; and in hot climates are accustomed to tramp about the ship without shoes or stockings. Their feet and legs are consequently bitten by mosquitoes, and, when the men have been a considerable time on a salt diet, and in the hot climate, the wounds ulcerate. The ulcerations become larger every day, and will resist all kinds of local treatment, so long as the diet remains unchanged. But, upon a change of diet, and cruising in a cooler latitude, the ulcers heal spontaneously.

Under analogous conditions—of unwholesome or insufficient diet and confinement—fractures in a hospital will remain only partially united; but upon the patient's removal into the country, cure is completed.

When a patient undergoes a formidable surgical operation, and makes a good recovery, the blood is regarded as of normal constitution, free from any taint or distemper. On the contrary, when trifling wounds and accidents degenerate into chronic ulcerations, it is reputed unhealthy. And the unhealthiness or impurity may be limited to the plasma, or that part of the blood from which elements of repair are taken. At all events, it is a question or matter for inquiry, which part of the blood is most in fault in these cases. "A person shall have a sore upon the leg, which is granulating freely," says Mr. Hunter, "when all at once the granulations shall lose their life, and fade away. New granulations may afterwards spring up, and these shall undergo the same process, and so they would continue to go on, if some alteration in the nature of the parts be not produced." That is to say, some alteration in the plasma or fluid of the blood; differences in the nature of granulations being determined by differences in the qualities of the plasma. These examples are sufficient to shew—what indeed is well known—that forms of inflammation, suppuration and ulceration, are produced and kept up by distemperature or unhealthiness of blood, and more particularly of its plasma. And that a depurative operation is often performed on the plasma, by forms of local inflammation, may be argued from the eruption of small-pox. In scarlet fever, that a contagious matter from the blood is discharged by the vascular action in the skin, may be concluded from the properties of the particles of the exfoliating epidermis. And in gout, that offending matter is discharged from the blood by the local inflammation, is also to be concluded from the morbid material deposited in the parts inflamed.

For demonstrative evidence of forms of inflammation dependent on distemperatures or dyserasies of the fluid of the

blood, we may refer to the *chef d'œuvre* of pathological anatomy, the great work of Rokitansky, also to the lectures of Mr. Paget. Actual proof of alterations in the qualities of the plasma may often be obtained by venesection, in cases of inflammation. The speedy separation of the plasma, or sinking of the corpuscles, which occasions buffed blood, indicates a change in the relative qualities of the two parts of the blood. We have recorded the yellowish, greenish, and purplish hues, and the flocculated appearance like curdled soap in the plasma, of buffed blood before its coagulation in different cases of inflammation. And we have repeatedly observed with the microscope differences in elements of the plasma of blood, taken from within the sphere of inflammation, as compared with elements of the plasma of blood drawn exterior to it. It would seem, then, that abnormal qualities of the plasma promote forms of inflammation; and the disposition of the colourless corpuscles of blood to congregate and attach themselves to the coats of the vessels, we may suppose to indicate a way whereby disqualified or abnormal portions of the plasma are transferred to the common tissue for discharge.

In the first part of this lecture, we spoke of the severance of blood-vessels and other bonds of connection between sloughs and the subjacent texture without bleeding. In abscess and ulceration, from thorns and other foreign bodies impacted in the flesh, we showed that great changes take place in blood-vessels without bleeding.

In fact, in all cases of repair, where exudations and new growth appear, the blood-vessels engaged undergo a change from fibrous to corpuscular—their component elements retrograde. This change is exemplified in granulations, the vessels of which bleed upon the slightest touch. We have a perfect conviction that, in places of inflammation, from disordered qualities of the plasma, the coats of the blood-vessels undergo the same changes; for we find that corpuscular elements of the plasma form, not only the coats of new vessels which arise during inflammation, but also supplant the fibrous element of the coats of the older vessels, which must be opened to supply blood to the new ones; and, as the plasma is the part of the blood which plays the conspicuous part in these changes, so it is not difficult to comprehend how it may be relieved of hurtful material in a place of inflammation.

"That sores give rise to very different kinds of pus," says Mr. Hunter, "is very evident to the naked eye, and that the different parts of which the blood is composed will come away in different proportions we can make no doubt; and we find that whatever is in solution in the blood comes away more in one kind of pus than in another." The inference is, that inflammation exercises a therapeutical action in distemperature of the fluid of the blood. Hence, then, inflammation, exudations,

granulations, and pus, may arise for two distinct purposes, namely: for the euro of mechanical injury; for the discharge of sloughs and foreign substances from the solid textures; and as a means of cure in distempered plasma.

In injuries to the common tissue, wounds, lacerations, contusions, and fractures, the process of repair comprises inflammation, granulation, suppuration, and ulceration; new blood-vessels are formed without bleeding, and there are discharges of pus. If physical hindrances interpose, the process is protracted and made chronic until they are removed. If they cannot be removed, the life of the person is endangered, and may be destroyed unless amputation be performed.

In distemperature or injury to the quality of the fluid of the blood, by unwholesomeness of diet, privations, or other causes, reactions of the same kind arise for its depuration. These also comprise inflammation, granulation, suppuration, and ulceration; boils, pustules, eruptious, and gout. If hindrances interpose—if the causes of the distemperature comprised in errors of diet, privations, etc., be not abated, the process is protracted and made chronic until they are removed, and in such cases, as in the sailor's before mentioned, to cure the local affections (the ulcers), the qualities of the plasma must be altered or improved by a thorough change of diet or habits of life.

In the one group—injuries to the solid texture (surgical cases)—the reactions arise for the healing of wounds, the discharge of sloughs, dead matter, and foreign bodies. There is direct evidence of what occasions the action, what it accomplishes, and why it is protracted and dangerous. In the other group—disorders of the blood (medical cases)—the influence of the reaction upon the qualities of the fluid of the blood can only be inferred from collateral events; and these, in gout, small-pox, and the other exanthematous fevers, point unequivocally to the therapeutical characters of inflammation.

In perusing such cases as Mr. Lowdell's, we cannot fail of remarking the advantage the surgeon has over the physician, in being able to go safely beyond the things which are seen. At the bottom of fistulous and ulcerated openings in the flesh, beneath an inflamed and thickened integument, and through a thick crust of new grown bone, he is able to assist, or rather to accomplish the task nature has long been endeavouring to perform. He lays his hand upon the hindrance which has made inflammation chronic, plucks it away, and the person is restored to health. Likewise in other severe injuries, a compound fracture or a crushed joint, the surgeon surveys the whole of the injured parts, and he has time and opportunity, before therapeutical reactions set in—before inflammation, suppuration, granulation, and ulceration have commenced—to form a judgment of the most probable course of events; and if, upon con-

sultation, serious doubts be entertained whether or not the cure should be entrusted to the natural course, he amputates the limb.

The physician is very differently placed. The inflammations he has to deal with arise from qualities in the blood itself; and when he has protracted and dangerous forms to deal with, he cannot lay his hand upon the cause of danger and take it away.

From the facility with which reactions between the fluid of the blood and its containing vessels may be studied in mechanical injuries, has arisen the *doctrine of repair*, daily exemplified in numerous examples.

But reactions of the same kind, from changes in the quality of the blood itself, owing to the difficulties surrounding their explication, have been separated from the ordinary process of repair. Our object will be to accumulate evidence of the propriety of bringing all reactions between the plasma and the common tissues, the process of repair and inflammation, into one—the physiological—category, and to shew that failure of success, in cases of inflammation of blood-origin, no more alters the nature or intent of the action, than does failure of success in necrosis of bone, and in other surgical cases. But further argument upon this matter must be reserved until we have spoken of the corpuscles of the blood.

V.—Of the Red Corpuscles of the Blood.

The development of the red corpuscles of blood is doubtless conducted on the same principle as that of other cells. They take from the plasma, in which they swim, the materials requisite for their growth, and excrete the products that must be consequent on the act of absorption.

"The only hypothesis," says Dr. F. Simon, "regarding the preservation and growth of the blood-corpuscles, is that their increase in bulk is due to a reciprocal action between the young corpuscles and the plasma; and that, as independent organisms in circulation, every change which occurs in them must be accompanied by a simultaneous alteration in the plasma, from which they obtain their nutriment, and into which their excretions must pass." And of the excretions passed into the plasma, those of them which are injurious are withdrawn therefrom by the depurating parenchymatous organs—the secreting parts of the skin, liver, and kidneys.

Now if we treat the red corpuscles as independent organisms, swimming in the plasma, then any matter or substance, whether derived from the plasma or from the atmosphere, which is necessary to their sustenance, to their normal state and functions, may be regarded and spoken of as nutriment. That is to say, we may speak of the corpuscles of the blood as nourished by elements in the air, as well as by elements of the plasma; and,

as respecting the matter they excrete or discharge, it is a part only of their excretions which is passed into the plasma: for certainly another part of their excretions is discharged into the air in the form of carbonic acid, by respiration. Let us pause for a moment to consider this matter. The leaves of a plant take in part of the materials of the nourishment of the plant from the atmosphere, and they excrete or discharge into the atmosphere elements that would be injurious to the economy of the plant if retained in it. Also the rootlets of a plant take up other materials of nourishment from the soil, and they excrete into the ground matters which they do not want. In both these examples, in the roots and leaves of the plant, the bodies which perform these offices of absorption and excretion, are microscopic cells—organisms analogous, and in many respects similar, to the blood-corpuscles.

Animals inhale the air and discharge into it matters which are thrown out from the body by respiration; and, in their nutrition by diet, they cast their droppings or excretions upon the herbage, on which they must afterwards feed.

Unicellular animalcules, in a drop of water, derive from it elements of their nourishment, and also they must discharge into it the matter of their excretions. In a *vivarium* water is the medium sustaining different forms of life, and the fluid is preserved in a fit and proper state, because the excretions of the animal furnish nutriment to the bodies of vegetable life, and because, on the other hand, the excretions of the vegetable furnish elements of nourishment to the animal bodies: the excretions of one department of life furnishing food and necessaries to the other department.

There is, therefore, nothing incongruous in the corpuscles of blood taking part of their nourishment from the air, and discharging into it a part of the matter of their excretions; and in their taking another part of their nutriment from the plasma, and discharging into it another part of their excretions. Nor, again, is there any incongruity in our finding that the plasma, or fluid of the blood, maintains its purity because the excretions of the corpuscles are ingredients upon which the functions of the depurating organs are exerted. Nor, finally, if with Zimmermann and Simon we should regard the fibrine of the plasma as an exuvial matter, or excretion of the corpuscles, is there any incongruity in finding it to be an essential material, used in the maintenance and repair of the common blood-distributing tissue.

As respects matter passing from the corpuscles into the plasma, we are able to show, by some remarkable experiments, which will hereafter be fully related, that molecular and tailed forms of some material substance may be seen issuing out of them and passing into the plasma, without much alteration of their form or colour; and, to any one witnessing the experi-

ment, there can be no difficulty in concluding that the corpuscles, in their natural state, discharge matter into the plasma. It must be confessed that but little can be demonstrated of the vital and depurating processes constantly going forward in the blood of the living person. Nevertheless, in the absence of such demonstration, we are warranted, by the experiment just referred to, and by the undisputed teaching of physiology, in concluding that the corpuscles of blood are sustained in their vital and chemical qualities by the plasma and the air; also, that their excretions are passed, partly into the plasma and partly into the air. And, these properties of the corpuscles being established, there are some broad and acknowledged facts respecting venous blood and urea which claim our attention.

VI.—The Corpuscles of Blood, in the Performance of their Natural Functions, contain and excrete Matter which is poisonous to the Brain.

Blood is distributed by arteries; it returns by the veins. There is a great difference between arterial and venous blood. This difference is, for the most part, if not entirely, referrible to the corpuscles. The red colouring matter is contained within them, and the bright colour which is communicated to blood by oxygen, as well as the dark shade which is induced by the transmission of carbonic acid through it, are the actual shades of colour which we see in arterial and venous blood. Venous blood is necessary to the well-being of the liver, and also to the normal function of the lung; but, should venous blood be transmitted by arteries to the brain, it is well known that symptoms of poisoning begin.

No suggestion for the recovery of drowned persons has been attended with so much success as the "Ready Method" of the late Dr. Marshall Hall. The principle, therefore, upon which his method is founded, may probably be accepted as true.

"During the circulation," he says, "the oxygen inhaled by respiration unites with the carbon of the blood, forming carbonic acid, which is exhaled in its turn by respiration, except in cases where the respiration is suspended, as in drowning and other forms of apnœa. In apnœa, the carbonic acid retained in the blood poisons it; and the organs, beginning with the brain and spinal centre, are in their turn poisoned by this blood-poison. The circulation," he goes on to say, "without respiration, is a blood-poisoning process; respiration is a depoisoning process. By respiration, the carbonic acid poison formed during the circulation is eliminated from the blood, and evolved from the system."

The consumption of oxygen and the formation of carbonic acid stand in a direct ratio with the number or amount of the

blood-corpuscles, and with the number of respirations made in a given time. It is well known that the alteration of colour from arterial to venous, which blood undergoes by circulation, is an alteration which takes place *within the corpuscles*; also, that the re-arterialisation of blood by respiration involves a change in the corpuscles. It must be, then, that the qualities acquired by blood during circulation, and discharged by respiration, are qualities of the corpuscles, inasmuch as the change of colour, which denotes the change of quality, is observed in the corpuscles. When, therefore, symptoms of poisoning arise from the circulation of venous blood through the brain, the poison must be concluded as contained within, and as generated or produced by, the corpuscles.

Urine is a fluid separated from the blood by the kidneys; and urine contains a substance which, when applied to other tissues than those of the kidney, will act as a poison. Sir H. Halford met with five instances of suppression of urine in the course of seven-and-twenty years practice, and in every instance the patient died from poisoning of the brain. It is but reasonable to infer that urea, which is separated in large quantity from the blood by the kidneys, should be a product of the metamorphosis of a substance of an invariably uniform composition.

"Amongst all the higher classes of animals," says Dr. Simon, "and many of the lower, in the most varied forms of existence, and under the most opposite kinds of food, we find urea and uric acid, or one of the two, as a constant secretion of the kidney. It seems opposed to all reason to imagine that, in animals as different in structure as they are opposite in their habits of life, and under every possible variation of circumstances, these fixed and definite compounds should be products of the metamorphosis of the plasma. It is easy, however, to conceive that the corpuscles which, although different in their form, are similar, if not identical, in their chemical constitution, in the blood of all animals, should yield similar products as the result of their metamorphosis."

If this reasoning be admitted—and it is urged with much force and perspicacity by Dr. Simon—it follows that urea, or a nitrogenous substance represented by that compound, and withdrawn from the blood by the kidneys, is an excretion of the corpuscles discharged into the plasma. Hence carbon or carbonic acid is an excretion of the blood-corpuscles discharged at once into the atmosphere; whilst urea is an excretion discharged into the plasma, and withdrawn therefrom by the action of the kidneys. Both these substances, if unduly retained in the blood, act as poisons to the brain; and we must conclude that the corpuscles of blood, in the performance of their natural functions, generate matter which is poisonous to the brain. Qualities within the corpuscles, if not discharged

by respiration, and other excretions, if retained in the plasma, are poisonous.

The properties of the corpuscles, then, substantiate the argument drawn from a consideration of the properties of the plasma, as to the necessity for holding the two parts of the blood distinct, pathologically as well as physiologically. The corpuscles are independent organisms, and the plasma is the fluid in which they swim. The properties of the one are very different from the properties of the other.

VII.—Relations of Diet to the Plasma, and of Air to the Corpuscles.

The normal constitution of the blood is preserved by diet and respiration. The alimentary canal and the lungs are the only two channels by which outward material substances are received into the interior of the body. Both have reference to the blood; diet, or food and drink, to the replenishment of the plasma; air to the nourishment of the corpuscles. The alimentary canal is, as it were, the coarser way by which substances are received into the body; whereas, in the structure of the lung, everything is fashioned with special reference to the admission of aerial elements into immediate contact, as it were, with the highest elements of the circulating fluid—the corpuscles of the blood.

As the plasma is subjected to a continuous change and consumption during the nutrition of the body, it becomes a matter of necessity that it should also receive a continuous supply. This is afforded to it by the chyle. Chyle is derived from substances received into the stomach—food and drink; it mingles with and augments the bulk of the plasma; and it is from the plasma that the red corpuscles derive part of their nutriment. There is, therefore, a more intimate relation between diet and the fluid of the blood, than between diet and the corpuscles; that is to say, any substance or poison entering the blood from food or drink must first enter and mingle with the plasma, before it can come into contact with or affect the corpuscles. But the case is different as between the corpuscles and the atmosphere.

From the peculiar distribution of the capillaries, and from the extreme thinness of the walls of the pulmonary air-cells, the blood-corpuscles are brought in the lungs into almost immediate contact with the air, and with the substances contained in solution in the air. The absorption of air through the humid membrane of the air-cells of the lungs is facilitated by the immense extent of surface presented, over the whole of which a thin stratum of blood-corpuscles is simultaneously exposed to the atmospheric influence. The permeability of moist membranes by fluid and gaseous substances is a well known fact;

dark or venous blood, inclosed in a moist bladder, and exposed to the air, soou assumes the arterial tint.

"I asked Mr. Boulderson," says Bishop Heber, in his *Narrative of a Journey through the Upper Provinces of India*, "if it were true that the monkeys forsook these jungly forests during the unwholesome months. He answered, that not only the monkeys, but everything which has the breath of life, instinctively desert them from April to October. The tigers go up to the hills; the antelopes aud wild hogs make incursions into the cultivated plains; aud those persous, such as dâk-bearers and military officers, who are obliged to traverse the forests in the iuterveuing months, agree that not so much as a bird can be heard or seen in the frightful solitudes; yet during the time of the heaviest rain, while the water falls in torreuts, and the cloudy sky tends to prevent evaporation from the ground, the forest may be passed iu tolerable safety. It is in the extreme heat, and immediately after the rains have ceased, in May, the latter end of August, aud the early part of September, that it is most deadly. In October, the animals return. From the middle of November to March, troops pass and repass; and, with common precaution, no risk is apprehended."

This may be an extreme instauce, but it is one of a very numerous class. It is well known that miasms or poisonous substances are diffused through the air, and that they exist in a very concentrated form at certain times, in particular localities. To euter in detail upon this topic is quite unnecessary. The question which arises upou the view we have taken of the constitutiou of the blood—of the relations of diet to the plasma, and of air to the corpuscles—is, whether the contagious fevers to which aerial poisons give origin are to be referred to the plasma or to the corpuscles.

VIII.—The Corpuscles of the Blood have a Property of Resistance against injurious Agents; they are not disordered or disturbed by every Quantitative Change in the Plasma.

First, as respects symptoms of poisoning through articles of diet, or through substances taken by the stomach, in food or drink: the poison enters the plasma, mingles and circulates with it. Through the plasma it must reach all, but it may affect injuriously one only of the parenchymatous organs: for example, mercury the salivary glands; opium the brain; strychnia the spinal marrow; digitalis the heart; and so on of many other poisons which exhibit their action according to the affinities of the different pareuchymatous organs for particular poisons. In all these examples, the symptoms begin in, and may be limited to, some local parenchymatous organ, notwithstanding the geueral distribution of the fluid

which contains the poison. It cannot bo disputed that the same poison does not act equally upon all the parenchymatous organs, though all may be exposed to its presence. Some suffer derangement; others do not. And if, to account for these special phenomena in one organ only, we introduce the doctrine of affinity or predilection, we must also allow to those parenchymata which escape a measure of indifference or resistance. This teaching holds a prominent place in chemical philosophy. Affinities and resistances are as often argued of inorganic as of organic or living hodies.

The corpuscles of blood are quite as much a group or community of independent organisms as are the special elements of the liver, hrain, or kidney; and, if the elements of one parenchymatous organ can remain indifferent to or resist the injurious action of a poison circulating in the plasma whilst the elements of another are suffering from it, it is not unreasonahle to infer a similar property of indifference or resistance in the corpuscles of blood. We have frequently tried the effect upon the corpuscles of substances which, if present in the plasma, will poison the hrain or nervous centres, such as solutions of prussic acid, morphia, and strychnia; and we find they produce no other or more effect upon them than so much water.

But, without relying upon experiments of this kind, we take the general principle, and argue for the blood-corpusclos the same kind of properties as is allowed to other cellular elements to the elements of the parenchymatous organs. And we say the hlood-corpuscles may resist the action of, or be indifferent to, sundry matters in the plasma, which may nevertheless be producing disorder in some local parenchymatous organ. Let it be observed, the argument does not assume that poisons which first affect the brain or other local organ, will not affect the corpuscles also, if in sufficient or overwhelming quantity; but only that there are many suhstances which, heing present in the fluid of the blood in small quantity, will affect its qualities injuriously in relation to a parenchymatous organ before sensihly disturbing the corpuscles.

Secondly, as respects poisoning of blood through miasms in the atmosphere; it is here to be observed, that the poison is received through the lungs, where the corpuscles are brought into contact with the air, and with the things in solution in it; and where, moreover, as has been shown, the physiological function performed is one specially between the corpuscles and the air. The chango which blood undergoes in the lungs is specially a change in the corpuscles.

Through diet, and through tbe atmosphere, elements of blood-disorder may enter. Through the former the plasma or fluid, through the latter the corpuscles, are first affected. The qualities of the plasma undergo numerous limited changes,

from diet, and from various other substances received through the stomach. But it does not follow, necessarily, that the corpuscles must suffer a disturbing change in consequence thereof. They have, up to a certain extent, a property of indifference, non-affinity, or resistance; and therefore maintain their normal constitution and function under various limited alterations of the fluid in which they swim.

On the other hand, from contact of the blood with poisonous substances in the atmosphere, the corpuscles, by reason of the special function of respiration, may be the first part of the blood to suffer disorder; whereupon their disordered condition is reflected upon the plasma, because this fluid is the depository of their excretions. That is to say, from errors in diet, or from poisonous substances taken by the stomach, the blood may be deteriorated in one only, and that the least important of its parts—namely, the plasma; whereas, from poisonous substances in the atmosphere, blood may be deteriorated, commencing with the corpuscles. And, as it cannot be denied that a poisonous quality in venous blood is referrible to the blood-corpuscles, so therefore the question arises, whether pathological poisons—if we may so call them—the virus of small-pox, and other contagious poisons, are not also to be referred to the corpuscles of the blood; and, should this proposition be established, the physical difference between the two parts of the blood rises into great importance.

Let us briefly recapitulate the physiological facts upon which we shall rely in our future discussion of phenomena of fever and inflammation.

The corpuscles of the blood are independent organisms, swimming in the plasma, deriving from it and from the air, materials suitable to their growth and functions, and discharging into it and into the air, the matter of their excretions, namely: carbon, or carbonic acid, into the air, and a nitrogenous compound, or urea, into the plasma. Depurating organs, located at various points of the circulation, withdraw from the plasma the matters which, if retained in it, would injure its qualities or composition, and the elements of the different depurating organs bave different or special affinity for different substances in the plasma. We have dwelt specially on the change which the corpuscles experience in their colour by exposure to the air in the lungs, and upon the poisonous quality they acquire if the normal change is not effected; and we have shown that these bodies, if they take or select from the plasma and from the air materials suitable for their maintenance, must have, in common with other cellular bodies, a property of indifference, or resistance to some extent, against deleterious substances.

As respects the plasma, or fluid of the blood, we have noticed the close relation between it and articles of food or drink

through the chyle. Substances received into the stomach in diet and poisonous substances taken in the same way may be speedily detected in the secretions, therefore the plasma must be a fluid of variable composition: and its relatively inferior position to the corpuscles was argued from these facts, and from the treatment of cases of cholera in 1832, by large quantities of a saline injection, thrown into the blood.

The conclusions at which we have arrived are:—

That changes in the qualities of blood from errors in diet, or from poisonous substances taken through the stomach, commence in, and may be limited to the plasma; whereas changes in the qualities of blood, from poisonous substances dissolved in the air and inhaled by the lungs, may commence in the corpuscles. In the latter case both parts of the blood become disordered, not simultaneously, but in succession; the corpuscles first and then the plasma.

These conclusions are not strained to the support of any favourite theory. The great physical difference between the fluid and the corpuscles of blood; the absolute manner in which the fluid depends upon diet, food and drink; the contact of the corpuscles with the atmosphere in respiration; the change in their colour and properties which ensues; the matter poisonous to the brain which arises within venous corpuscles; the action of the depurating organs upon the plasma, exhibiting special affinities;—all these are received doctrines of physiology, or flow logically from them; and we make them the basis of a therapeutical doctrine in blood-diseases, distinguishing between the fluid and the corpuscles.

LECTURE II.

IX.—Fever.

When a person is inoculated with the virus of small-pox, a poison is introduced into the body—nay, into the blood. That it distempers the blood, is concluded from the generality of the symptoms.

These are, rigors and shivers over the whole body; to which succeed a fever, hot skin, quick pulse, and general illness, accompanied with severe pain in the back and head, inclination to vomit, pain on light pressure at the pit of the stomach, stupor, and drowsiness.

Counting from the first invasion of the fever, the pustules of small-pox arise on the fourth day, rarely sooner. At first very small, they grow greater every day, and rise more and more to a head filled with pus. About the eighth day, the spaces between the pustules look red, and the hands and face swell. On the eleventh day, the swellings are evidently going down, and the pustules have reached their full magnitude. At this time, the fever has greatly diminished or wholly vanished.

Matter taken from any of the pustules will reproduce the fever with certainty in a person who has never had it. The virus, therefore, has been multiplied a myriad-fold—regenerated in the body of the patient. And the question proposed is: To what element of the tissues or of the blood is the reproduction of the virus to be attributed? The pustules do not make their appearance until some days after the fever; excluding them, therefore, from any share in *generating* the virus, the plasma and the corpuscles of the blood remain for examination.

Liebig, it is well known, ascribes the phenomena which succeed the introduction of the small-pox virus into the blood to a process exactly resembling fermentation. Yeast, he says, is putrefying gluten, and its component particles are therefore in a state of intestine motion or transformation. And he lays down the proposition—that a substance in the act of decomposition, added to a mixed fluid in which its constituents are contained, can reproduce itself in that fluid exactly in the same manner as new yeast is produced when yeast is added to liquids containing sugar and gluten.

Thus the virus of small-pox, which virus is formed out of blood, causes such a change in blood as gives rise to the re-

production of the virus from the constituents of that fluid; and the transformation is not arrested until all the particles of the blood which are susceptible of the decomposition have undergone the metamorphosis.

Admirable as this teaching is, there is another view of the matter. Naturalists insist that yeast is a growing plant; and physiologists insist that changes in a medium in which living bodies grow, are to be referred to other laws than those of ordinary chemical affinity.

In the January number of the *Quarterly Review*, for the present year, the writer of the article "On Bread" says:—"The yeast-*plant* represents one condition of a species of fungus remarkable for its wide distribution and the magnitude of its effects. The forms in which it is familiar to most persons, are yeast, the vinegar-plant, and the common blue mould which occurs on sour paste. Yeast and the vinegar-plant are the forms in which it vegetates under various circumstances, when well supplied with food. Mildew or mould is its fruit. The yeast-plant," he goes on to say, "is a wasteful feeder. Not only does it decompose so much of the liquid as it requires for its own nutrition, but it produces a similar decomposition in the liquid around it; and this *contact-action* is at present a stumbling block to natural philosophers, many of whom are earnestly endeavouring to surmount it. The chemist refers it to the same unexplained force by which inorganic substances cause the combination or separation of substances, without themselves undergoing alteration; as when spongy platinum causes a mixture of oxygen and hydrogen gases to unite and form water."

Many thoughtful and learned men have protested against the prevalent tendency to explain all vital phenomena by physical and chemical laws only, without regard to the order of conceptions specially belonging to vital phenomena. However this may be, the multiplication or increase of a contagious virus—such as that of small-pox in the blood of a living person, its discharge by the pustules of the skin, and the patient's recovery from it—may *à priori* be assumed to be something more than a simple physical fact.

But let us state the argument, from which we shall conclude that—

X.—The Virus of Small-Pox is Generated by Abnormal Metamorphosis or Disease of the Corpuscles of the Blood.

It has been established by unquestioned microscopical observations, that the qualities and secretions of an organ are aggregates of the qualities and secretions of the minute cells which compose it. In vegetable structures, the qualities of the

leaf are produced by, and reside in, the cells of the parenchyma of the leaf. The colours of petals and the qualities of fruits are aggregates of the qualities or properties of the cells composing these parts.

In animal bodies, the qualities and secretions of the liver, skin, and kidneys, are known to be produced in the cells or particles composing the parenchyma of these organs. In all cases that are known of the generation of poisons in a living body, the poison is a product of cell-metamorphosis. It is so in vegetable bodies—instanced by opium, strychnia, belladonna, etc.; the properties of the juice of the poppy and of other plants being generated in the cells of the plant. So also in animal bodies; the poisons of wasps, bees, and serpents, are generated by the metamorphosis of cellular bodies.

Analogously of blood, we have shown that some of its most prominent and important qualities are qualities of its corpuscles, of the cellular bodies floating in it. And we have discussed the physiological production of matter in the blood-corpuscles of the human body which is poisonous to the brain, namely, the matter of venous blood. When, therefore, as in small-pox, blood becomes the seat of a contagious poison which has been generated in it, there is a strong inducement to interpret the pathological fact by reference to physiological laws and phenomena. And this consideration has much more weight than might at first appear; if we find contagious fevers arise from exposure of the blood to miasms in the atmosphere, that the infection is received during respiration, and through the lungs, where we have actual proof that the corpuscles are naturally changed in properties and colour; and if not so changed, that they carry within them a poison through the body which disturbs the functions of the brain.

It seems opposed to all reason to infer that the small-pox virus, a matter of definite quality and action, often generated in the blood in very large quantities in a few days, should be referred to the plasma, a fluid of variable composition, when all analogy bases it in the corpuscles.

Upon these grounds, we put forth the following physiological interpretation of the phenomena which succeed the introduction of the small-pox poison into the blood by inoculation. The corpuscles of the blood, passing in the vessels at the moment these are wounded and opened by the instrument which introduces the virus, are the first affected by it; and from them the rest of the corpuscles are infected by contagion, or contact-action. The spreading of disorder from corpuscle to corpuscle throughout the blood, is denoted by the fever, which rises daily greater and greater, until inflammation and pustulation are established.

The physiological demand is here deemed analogous to that where abscess and ulceration is established for the expulsion of

a thorn or a slough. That is to say—in thorns, sloughs, and necrosis of bone, the demand is for the expulsion of an injurious body from the solid texture (the common tissue.) In small-pox and other fevers, the demand is for the expulsion of some hurtful matter from the plasma of the blood. In both examples, forms of inflammation are the phenomena.

Life is a state of constant antagonism to the forms of dead matter; and any injury or decomposing tendency excites reaction. The corpuscles of blood, infected with a contagious poison, therefore, react against it; they excrete, throw off, or free themselves from the virus, and their countless multitude gives quantity to the products. The prosecution of the virus then devolves upon the plasma; and in small-pox, inflammation and pustulation in the common tissue of the skin is established for its final expulsion and the patient's recovery.

It is of no consequence to our interpretation of the reproduction of the virus of small pox, how the rival claims of chemistry and physiology are disposed of; for, whether the contagion does spread through the blood from particle to particle in the manner of a chemical ferment, or whether from corpuscle to corpuscle as from one living body to another,—whichever form of words or ideas is chosen, the proposition that the corpuscles are the particles of the blood through which the poison operates is agreeable with, or remains unshaken by the acceptance of either explanation. But, whatever be the order of our conceptions as relates to the regeneration of contagious poisons in the blood, whether chemical or vital, the same ought to be carried out in its consequences. Therefore, if the origin of the small-pox poison be referred to a chemical ferment, the origin of other poisons in plants and animals ought also to be referred to chemical action. Should this be done we may truly dismiss vital action and vital conceptions altogether from the scene. Are we yet prepared to go these lengths? Much consideration, we think, is demanded before an affirmative answer be given.

The assumptions necessitated upon either view of the phenomena of small-pox disease may be considered as in favour of the physiologist. On the one hand, by the chemical philosopher it is assumed that yeast is decomposing gluten; that the growth of yeast is a progress in decay; that the small-pox virus is in a state of intestine motion, and that this commotion is communicated to some unknown particle or ingredient in the blood. On the other hand, the physiologist does no more than state that yeast is a living plant; that the corpuscles of blood are living organisms with the properties of other cellular bodies, namely, growth and metamorphosis, and that some of them, infected by injurious matter imbibed from the air or otherwise introduced into the blood, communicate disorder to the rest by contagion, or contact-action. Of these two interpretations, the

chemical one is unsatisfactory, because it breaks up all our ideas of peculiarities in living bodies; it leaves unexplained numerous other examples of contact-action in physiology, and it refers indefinitely to particles in the blood, without distinction between the plasma and the corpuscles; whereas, we point specifically to bodies floating in the fluid of the blood of the same class or kind with other bodies which are known to generate poisons, both in animal and vegetable structures, and which, moreover, in the human structure do unquestionably generate and contain the matter or poison of venous blood. Lastly, there seems a preponderance in favour of the interpretation which bases the phenomena of small-pox fever upon the corpuscles of the blood rather than on the plasma; because, as we have said, in all instances known of the generation of poisons in living bodies, animal or vegetable, the production of the poison is a function of analogous bodies.

The regeneration of a contagious virus in the blood and symptoms of fever go together; therefore, if the production of the virus be rightly ascribed to abnormal metamorphosis of the corpuscles, phenomena of fever must be based upon the corpuscles. It is to be examined, therefore, by what facts we support this more general conclusion.

Gout is a disorder attributed to altered qualities of the blood. Yet it forms a strong contrast with small-pox and other fevers; and from this contrast the suggestion arises, that if in either of the two diseases, gout or small-pox, the *materies morbi* can be fairly allocated to one part of the blood, the place of the other will have been found.

Now the close dependence of the plasma upon articles of diet, and the argument that the plasma may become distempered without necessarily involving the corpuscles, have been discussed. Gout is a disorder substantiating the argument. For its access is promoted in a very remarkable manner by a full and luxurious mode of living; and the more surely, if this be conjoined with a sedentary and inactive habit, which is known to produce inactivity in the depurating organs. The attack commonly comes on without previous warning. The person goes to bed and to sleep, thinking himself in his usual health, and is awakened in the middle of the night with pain and inflammation in one of his feet. If there be any previous indications of the approaching attack, they are referable to the digestive and depurating organs; such as diminished and high coloured urine, diminished appetite, flatulence, and, perhaps, some slight diarrhœa, or its opposite constipation.

In gout, inflammation is the primary and diagnostic phenomenon. That it is a depurative action is shown by the result. There is no fever. A *materies morbi* is deposited at the place of inflammation; but this is not contagious. By proper medical

treatment the natural depurating organs—the skin, bowels, and kidneys—may be stimulated to assist in removing the offending matter from the blood, so that the inflammatory reaction may be either shortened, mitigated, or altogether extinguished.

In contrast with this sketch of the phenomena in gout, contagious fevers arise in a different way; not through errors in diet, but from poisonous substances inhaled by the lungs or ingrafted into the blood. Symptoms of fever are primary features of the disorder. A contagious virus is generated in the blood, and inflammation is consecutive or secondary, following after symptoms of fever, because the plasma is distempered, not primarily, as it is by errors in diet, but consecutively, through the excretions of the previously diseased corpuscles.

These statements, we apprehend, contain the ground of distinction between erysipelas, as a local inflammation, and erysipelatous fever; rheumatism and rheumatic fever. In the local inflammations without fever, the plasma only; in the fevers, both corpuscles and plasma are disordered.

As this is an important point of our subject let us recapitulate the facts:—

Diet replenishes the plasma; and the plasma is the part of the blood from which elements of repair and inflammation are taken. Unwholesomeness of diet disorders the qualities of the plasma, and produces gout, an acute inflammation without fever; and morbid matter from the plasma is deposited at the place of inflammation. There are other inflammations where evidence of a depurative action upon the fluid of the blood appears.

Air acts directly on the corpuscles of the blood, which are bodies with the properties of cells. From substances in the air fever arises; and in fever a contagious poison is generated in the blood. The corpuscles of the blood naturally contain within them the matter of venous blood, which is poisonous to the brain. And in other instances—in vegetable and animal structures—bodies, analogous to the blood-corpuscles, are the organisms in which poisons are produced.

From these facts, we draw the general conclusion that abnormal metamorphosis, or disease of the corpuscles of blood, is the antecedent of fever; and distemperature of the plasma the antecedent of inflammation.

XI.—Inflammation as a Therapeutical or Depurative Reaction, in Cases of Fever.

In some fevers, or in some cases of fever, the natural depurating organs are sufficient; or, by proper medical treatment, they may be roused to a sufficiency for the elimination and

discharge of the morbid matter made over to the plasma from the diseased corpuscles. If this can be accomplished, there will be no call or necessity for any preternatural depurative reaction between the plasma and the common tissue. In such case, therefore, the person has, and must go through, the fever; that is to say, the blood-corpuscles must pass through the phases of their disorder; but he is saved, by judicious medical treatment, from a local inflammation, because distemperature of the plasma, consequent upon disorder of the corpuscles, is met and relieved by the natural working of the depurating organs. These organs act upon the plasma; and inflammation is an action between the plasma and the vessels. By one or the other, or by both ways, the fluid of the blood may be relieved of hurtful matter: and, as the severity and duration of symptoms of fever are a measure of the severity and duration of disorder in the corpuscles, so, we apprehend, the severity and duration of the consecutive inflammations are a measure of ease or difficulty with which the morbid matter separates, or sloughs off, from the rest of the fluid, and is made over to the common tissue for discharge. But, in cases of fever, we apprehend that neither the natural organs nor inflammation can effect this depurative purpose, so long as disorder is limited to the corpuscles.

The *materies morbi* of the corpuscles—of whatsoever nature this may be—must leave them, and be discharged into the plasma, before any depurative means can come into play for the final expulsion of it from the fluid of the blood. This appears to be the *rationale* of our inability, by any means which have hitherto been tried, to cut short the progress of a fever.

The argument respecting the therapeutical properties of inflammation in distemperatures of the fluid of the blood was partially discussed in the first lecture; and we now proceed with what further we have to say on this subject.

Case. At 8 o'clock in the morning of Dec. 28th, a physician, who was assisting at the *post mortem* inspection of the body of a lady who had died of puerperal peritonitis, unfortunately pricked his finger. Twelve hours afterwards, he felt some pain at the part; and he had it touched with nitrate of silver. During the night, shiverings came on, and he felt extremely restless. On the morning of the 29th—the next day—the finger was swollen, and red lines extended up the arm. In the evening of that day, the symptoms were not abated, and there was great prostration. On the 30th, the hand and arm were greatly swollen, the glands in the axilla were affected, and the pain was very great. On the 31st, the pulse beat from 90 to 100 in the minute; and the breathing was heavy and irregular, with torpor and drowsiness. In the evening, all the symptoms were increasing; and now an erysipelatous blush

from the axilla extended over the side of the chest. During the night, the breathing became difficult, and the drowsiness passed gradually into deep stupor. Death took place at six o'clock in the morning of January 1st, not quite four days from the infliction of the wound.

In this case, the phenomena, in all important respects, are similar to those observed in traumatic erysipelatous fever, and in puerperal fever. The circumstance of the disease arising in the manner related—namely, from inoculation of a poison from the body of another person who had had puerperal fever—establishes the relation between it and the contagious fevers, and shows that the fatal termination in so short a period is to be attributed, not to inflammation, but to disease of the blood. If this be assented to, the case is taken out of the category of inflammatory diseases, and is placed in that of blood-diseases.

But if this and analogous cases—if erysipelatous fever, puerperal fever, gout, small-pox, and the other exanthematous fevers—be considered as blood-diseases, a great step indeed will have been taken, in the direction we are arguing, towards removing inflammatory reactions altogether from the pathological list; and a wide avenue is opened for a reconsideration of their true import.

Moreover, much doubt is thrown upon the value of the labours of the pathological anatomist, who may regard effects left by internal inflammation in fatal cases of blood-poisoning as showing anything whatever of the nature or seat of the disease. For the question arises, whether inflammation, and the suppurations which may appear in contagious fevers, are not appropriately placed in the same class with inflammation and suppuration in small-pox, sloughing carbuncle, and necrosis of bone; all of which are indisputably therapeutical reactions, the only difference being that, in the one class of cases, the actions arise for therapeutical purposes in the solid parts—the common tissue; in the other, for therapeutical purposes having reference to the fluid of the blood.

If we impartially review phenomena of inflammation as a matter of natural history, and begin with the simplest cases—scalds, burns, sloughs, and fractures (injuries to the common tissue), and boils, eruptions, gout, and small-pox (from injury to the qualities of blood)—we can scarcely fail of perceiving, in both classes, that the forms and amount of the action depend upon, or are governed by, the amount or extent of injury sustained. And, if hindrances protract the process of repair, so also analogous difficulties protract depurative forms of inflammation. If keeping peas in a sore protracts granulation and discharge, so also perseverance in unwholesome articles of food will protract ulceration. In mechanical injuries, the cause of the injury (the heel of the horse, or the cart-wheel), the part injured (the torn flesh, or the broken bone), the extent and

nature of the hurt (contusion, laceration, and comminution),—all these, and also the subsequent reaction (the process of repair), are objects either of sight or of touch, or of both. On the other hand, in injuries to the blood, all these things are, and to a great extent must remain, matters of reasoning and deduction. We have said, that very little can be demonstrated of the vital and depurating processes constantly going forward in the blood of the living person. In the engrafted small-pox, it is true, the poisonous matter introduced into the blood, and the consequent inflammation and suppuration in the skin, are seen; but the essential part injured—the elements of the blood—the extent of their injury, and the depurative reactions going on amongst them, and which connect the introduction of the virus with the fever, and the subsequent inflammation and suppuration, are not seen. Likewise, in the fatal case just related, there was evidence of the introduction of poisonous matter into the blood through the wound of the finger; but the rapidity with which it spread throughout, and destroyed the normal quality of the blood, was only to be proved by the rapid course of the symptoms and the fatal termination. In this case, we argue that the inflammation and swelling of the glands in the axilla were reactionary efforts to arrest the course and eliminate morbid matter, though they failed: and they failed upon the same ground that similar efforts fail in cases of severe mechanical injury; namely, because the injury inflicted on the blood was so great that life succumbed before measures of relief could come effectually into play. In severe mechanical injuries, persons sometimes die before, or soon after, a process of repair is established; so likewise, in injuries to the blood, persons will die before any inflammation appears.

XII.—Diseases of the Corpuscles of Blood.

With respect to disease or abnormal metamorphosis of the corpuscles of the blood, and its association with symptoms of fever, numerous observers have described their darker colour, and the easy transudation of their colouring matter in typhus. Denis, for example, describes the blood in typhus fever as deficient in fibrine. He says that air had no effect in reddening it; and, on analysis, it was found to contain ammonia. Dr. Armstrong observed the blood in typhus from the temporal artery as dark as that from the veins.

The general appearance of blood in malignant fevers has been described by Huxham and Fordyce. At the first commencement of symptoms of fever, the blood was sometimes buffed; but the clot beneath was always of a loose texture, scarcely cohering, and very dark in colour. If the patient was bled two or three days after the onset of fever, the blood was found incoagulable, having the appearance as when spirits of

hartshorn is added to blood as it runs from the vein, which darkens its colour, and prevents coagulation.

In the yellow fever of the West Indies, blood has been observed to be hotter than in health. As fever progresses, it becomes black and thin. Dr. Blair says that, in many instances, the corpuscles were found so much dissolved that, in several specimens of fever-blood, but few of them could be observed.

It has been found that a diminished amount of carbonic acid is discharged from the blood by respiration in cases of fever; and this fact, taken in conjunction with the dark colour of blood, is conclusive as to one, at least, of the functions of the corpuscles being disordered in fever.

Rokitansky, Simon, Perry, and many other accurate observers, all speak of the dark colour and changed state of the corpuscles of blood in maliguant fever, of the incoagulability of the plasma, and of the staining of the tissues and of the serum by the colouring matter which transudes the corpuscles.

As regards the microscopical appearances of the corpuscles of blood in fever, we hesitate at preseut to lay any stress upon them; because in persons in health, they very speedily change their figure and outline in a very uncertaiu manner. Some of them become notched with projecting points, and otherwise changed in outline; others assume globular forms; they are influenced as respects these changes, it would appear, by the temperature of the glass upon which they are received for examiuation, and by the way in which they are covered by the thin glass. Some are seen paler, and some smaller than others; some adhere closely together in rolls, others float about separately without the least disposition to adhere to their neighbours. All these varieties may be seen in the same small quantity of blood which is alone available for microscopical inspection, especially if the exterior edges of the film of blood be brought into the focus of the microscope.

Notwithstanding these obstacles to the drawing any positive conclusion from the microscopical appearances of the blood-corpuscles in cases of fever, it is quite as likely to be by the microscope as by chemistry that future advances in the pathology of these bodies will be made. For how can any bulky chemical manipulation satisfactorily eliminate results from the plasma from results from the corpuscles? especially if, uuder the influence of reagents, as we shall show, they throw out matter from their interior into the fluid in which they swim, and yet preserve their integrity or individuality. "Hitherto, at all events", as Rokitansky has well observed, "chemistry cannot be said to have excelled, as respects the pathology of theso bodies, the achievements of a circumspect anatomical survey, notwithstanding the limited resources at the disposal of tho latter."

Experiment i. Take a slip of glass, such as is used for mouutiug microscopical objects, receive on it a very small drop of blood, and place close to it with a pipette a drop of any fluid, chloroform, ale, weak sugar and water, etc., and the quantity of the extraneous fluid should not exceed the quautity of blood. Upon now dropping on the two fluids a thin piece of glass, their nearest edges will mingle, but in various proportions.

In these experiments we fiud the *outline* and the *interior* of the corpuscles of extremely various appearances in the same experiment, but nothing appears thrown out from them.

Experiment ii. Proceed as in the last experiment, but let the fluid used be sherry wine. The corpuscles, along the line where the blood and wine mingle, will soon begiu to throw out molecules around their circumference, many of which pass away into the fluid; others grow out into long tails, which remain attached to the corpuscles, and terminate in a knoh. They also wave about in a very siugular manner. After some time (half au hour), the tails or filaments become nodulated, and then break away from the corpuscles, and wheu they have done so, they continue their singular movements in the fluid.

Some years ago, when making observations on the plasma or liquor sanguinis of blood, drawn by venesection in cases of fever and inflammation, we observed in the fluid a vast multitude of minute molecules. (*Medical Gazette*, vol. ii, 1841-42.) And the molecules seen in the experiment here related, are precisely the same in magnitude and appearance as those we saw in the fluid of blood drawn in the cases of fever. Now we believe that the blood corpuscles do not immediately lose their vital or chemical properties wheu withdrawn from the body. Therefore, we regard the remarkable forms and actions they exhibit under the influence of sherry wine, as phenomena of a species of reaction, which, amongst multitudes of them, is various or unequal, hence the various appearauces preseuted. In some, the resistance offered to the extraneous fluid is more easily overcome than in others.

We have frequently examined with the microscope blood taken from persons affected with scarlet fever, with reference to the appearances in the plasma, aud have always noticed the following facts. The colourless or plasma corpuscles are much more numerous than in persons in health, and especially so if the blood be drawn from the skin as the fever is passing off and the epidermis beginning to exfoliate. They are of different sizes and present different appearances. In the open spaces between the rolls of the red corpuscles, irregular masses of granular matter and numerous free molecules are seen floating in the fluid.

In cases of diphtheria, we find that the plasma presents the same appearances as are seen in scarlet fever. Formerly we supposed the free molecules observed in the plasma of blood, drawn

in cases of fever and inflammation, to be derived from the colourless corpuscles; but now that we have seen them thrown out by the red corpuscles, there is actual proof that these corpuscles, in their reactions upon extraneous substances, do themselves throw off matter into the fluid in which they swim. The appearances, then, which we have seen in the fluid of the blood in cases of fever, and the behaviour of the corpuscles in the experiment we have related, appear to corroborate our conclusions respecting the excretions of the corpuscles passing into the plasma, and the association of these excretions with phenomena of fever.

Before proceeding with our argument, it will be convenient now to refer to some collateral incidents which require our notice.

First, it may be objected to our proposition respecting the antecedent of fever, namely, disorder or disease of the blood-corpuscles, that in venosity of blood, where a poisonous element of the corpuscles fails of being discharged by respiration, the symptoms are those of brain disturbance, and not of fever. In *morbus cæruleus* there is no fever necessarily.

To this objection it may be replied, that the presence of a venous quality in the corpuscles does not imply disorder or disease in them, in the same way that it is concluded to arise from miasms in the air. The substance—carbon or other matter—which gives to the corpuscles their venous character, is a substance natural to them, an essential ingredient of their composition in certain parts of their course in the circulation. Therefore, it is to be expected, it would occasion no unusual reaction on the part of the corpuscles themselves, though the brain suffers; whereas, a poison from the air may be presumed something quite heterologous to the corpuscles, and doubtless they react with more energy against a foreign injurious matter, than against anything which is a part of their normal composition.

In cases of blood-poisoning through the stomach, such as drunkenness from alcohol, narcotism from opium, and salivation from mercury, the locality and character of the symptoms point out which organ it is that suffers first or most from a particular poison diffused through the plasma. And if in these examples fever be absent, the argument is, that the parenchymatous organ is affected before the corpuscles of the blood, fever appearing when they partake of the disorder.

In cases of blood-poisoning through the lungs, on the contrary, the symptoms begin with fever, and the argument is, that the corpuscles of blood are here affected first, before the plasma or any of the local parenchymata; fever denoting an abnormal metamorphosis of the corpuscles.

A venous state of the corpuscles of blood is not an abnormal metamorphosis. The condition comprehended in the term

venous is one natural to them. Misplaced venous corpuscles disorder the brain; but fever does uot appear, because the veuous state is natural to the corpuscles. The abseuce of symptoms of fever, when venous blood circulates arterially, is therefore no valid objectiou to the proposition we are arguing.

Again, we have hitherto purposely abstaiued from any refer-ence to the braiu or nervous system as causes of fever and inflammation, not because we underrate their powerful influence over blood and the secretions, but because so important a part of our subject requires a special consideration, which we can here but briefly iudicate.

It has been argued in the former lecture, that the elements of the parenchymatous organs and the corpuscles of blood have the common properties of other living cellular bodies; aud among these are properties of affinity, which differ iu relation to different substauces. And there can be no doubt that the corpuscles of the blood, as respects the various substances thoy encounter iu their course during circulation, have much more intimate relatious with (or a greater affinity for) some than others. For example, in the luug, a special reciprocal action takes place between the corpuscles which are within the vessels aud the air which is outside them. And, as if to facilitate this action, the coats of the blood-vessels in the cells of the lung are reduced to an extreme degree of thinness.

Now, it may be argued of any other special organ, where the coats of the capillary vessels are reduced to a still greater degree of thinne-s than in the lung, tbat they are so for a similar purpose. Thus, iu tho brain, an orgau very largely supplied with blood, the coats of the extreme vessels are so thiu that we fail to trace them iu all their various ramificatious: indeed, so entirely are they altered that the elements of the organ have but a slight coherency. And, unless the contrary can be shown, we may infer tbis disappearance of the ordinary properties of blood-vessels to be for the purpose of removing all obstacle to the closest possible contact between the corpuscles of the blood and the parenchyma of the brain. This inference is corroborated by the fact that the braiu is the organ specially affected by au abnormal circulation of veuous corpuscles. That is to say, the brain is the organ which first detects the presence of au abnormal venous quality in the corpuscles.

If, then, we may regard the thinning away of the coats of the capillaries of the brain as facilitating a coutact-actiou between the corpuscles of blood and the substance of the braiu; and if, moreover, we are able to appeal to the knowu effect of venous corpuscles upon the functions of the brain denoted by drowsiness, stupor, deliiium, and coma, as proof of a special action between the brain aud the corpuscles, then we may claim the constant occurrence of similar cerebral disturbauces iu fever as corroborative of the view which bases pheuomena of fever

upon abnormal metamorphosis of the corpuscles of blood; tho brain—to use a chemical phrase—being the test of the condition of the corpuscles.

All the functions of a living body may be comprehended as a series of actions and reactions; and, if it be admitted that the corpuscles of blood do perform a special function in the brain, there must necessarily be reaction from the brain upon the corpuscles.

Case. A young married woman, aged 19, was delivered of her first child. The labour was natural, and she went on favourably until the fourth day from her confinement, when her husband stayed out late at night, and returned home drunk from a fair, very much knocked about. By this she was thrown into a state of great nervous excitement. Very shortly after, she was seized with a numbness of the legs and shivering, and then with pain in the head and wandering of the mind. The secretion of milk was interrupted; the skin became hot and dry; no sleep could be procured; and the pulse beat 120 in the minute. The wandering of the mind passed into furious delirium, and all the symptoms of fever and excitement continued for several days. It was only by judicious medical treatment and careful nursing that the disorder was subdued on the seventeenth day.

In this case, we argue that the fever arose, not immediately from the nervous shock, but from disorder of the blood-corpuscles; and, as our researches have led us to interpose distemperatures of the fluid of the blood between errors in diet and inflammation, and disorder of the corpuscles of blood between aërial miasms and fever, so analogously of mental emotions and nervous shocks, when they occasion or aggravate fever or inflammation, we conclude they do so by disordering, or adding to the disorder, of one or other, or both parts of the blood. Errors in diet do not produce inflammation, unless the fluid of the blood be distempered: also a miasmatous air does not produce fever, except the blood-corpuscles be affected; so, too, great convulsions and loss of consciousness (in epilepsy, etc.) pass away without fever, if the blood be not affected. The close sympathy between states of the corpuscles of blood and the brain, then, supports our proposition that symptoms of fever and the generation of poisons in the blood are to be based upon disorder of the corpuscles.

XIII.—Two Species of Fever.

In the last Lecture, we said that the corpuscles of the blood derive materials of their growth and nourishment from two sources, namely, the atmosphere and the plasma; and that their excretions are discharged in two ways—partly into the atmosphere, as carbonic acid, and partly into the plasma. It follows necessarily that the blood-corpuscles may be disordered

in two ways; namely, by injurious matter in the air, and by injurious matter in the plasma. Wherefore, if fever be the expression of disorder in the corpuscles of the blood, we should expect—because they may be injured in two ways—two forms of fever. And there are two forms of fever, designated respectively contagious and hectic fever. Having discussed the phenomena of contagious fever, we have now to speak of hectic fever.

The corpuscles of the blood, in common with other cellular bodies, have within certain limits a power of resistance against injurious agents. It is not every passing impurity of the atmosphere, nor every injurious change of quality of the plasma, that establishes symptoms of fever. Nevertheless, poisonous substances in the air do, we know, occasion contagious fever; and we propose to show that a sufficient debasement of the qualities of the plasma, by disordering the corpuscles, will produce hectic fever.

In necrosis of bone, it has been shown for what purpose inflammation arises; and why it fails, or is hindered of cure. The persistence of the hindering cause—the dead bone—gives chronicity or permanence to suppuration, ulceration, and fistulous openings in the flesh. It is notorious in these cases, and in the analogous ones of diseased joints, that hectic fever sooner or later appears; and the sooner, if the person with his permanent source of illness (the chronic suppuration), be also exposed to privations, hardships, or unwholesomeness of food. Again, in pulmonary consumption, where the blood is continually passing and repassing numerous places of suppuration, hectic fever appears. Numerous other examples might be given; but these are sufficient to show that protracted forms of inflammation—namely, chronic suppurations and ulcerations—are in some way antecedents of hectic fever. Now, when inflammation, suppuration, and ulceration are hindered and protracted, spoiled material from the places of suppuration may ebb back by the roots of the veins into the plasma.

In proof of this, we may refer to the great work of Rokitansky, his *Pathological Anatomy;* and we shall quote the thirtieth experiment related in the third series of our own experimental researches.

"Experiment 30. Select a small light coloured frog, with as few pigment-spots as possible, because these obscure what is going on in the vessels. Irritate the web of one of the feet by immersion in tepid water (97° Fahr.) for thirty seconds, and afterwards gently scratch it with the point of a needle, taking care not to wound or open any of the blood-vessels. At the expiration of an hour or two, upon examining with a microscope, several of the capillaries and small veins will be seen crowded with colourless corpuscles. Now let a weak solution of potash—one part of the alkali to three of water—be lightly

brushed over the web with a camel's-hair pencil, immersing the foot in cold water immediately after. In blood-vessels thus treated, we have seen red corpuscles glued together, and lumps of colourless matter passing away from the sphere of irritation along the widening channels of the small veins. Or these morbid matters, becoming stationary, have been the means of dividing the current of the blood into two streamlets within the vessels."

Such an experiment as this proves that local changes in the qualities of blood may be produced in places of irritation; and if in places of irritation, then also in places of inflammation and suppuration. And it shows, we think, in a satisfactory manner, how the mass of the plasma may become distempered by any continual ebbing back of spoiled material from places of protracted suppuration.

No one can doubt that the fluid of the blood is altered, and may be distempered, by unwholesomeness of diet, and by neglect of the daily excretions by the skin, bowels, and kidneys. It is also evident that these common sources of distemperature of the fluid of the blood must operate not only in persons in health, but also in persons who may be afflicted with chronic forms of inflammation, such as are present in necrosis of bone, in diseased joints, pulmonary consumption, etc. And if, in these last mentioned examples, distemperature of the fluid of the blood from errors in diet, or other such causes, concur with distemperature from absorption of spoiled matter from places of chronic suppuration, then there will be *deuteropathy of the plasma*, or disturbance of the qualities of the fluid of the blood from two points at the same time; namely, unwholesomeness of food and absorption of morbid matter. And it follows from the physiological relations subsisting between the corpuscles and the fluid of the blood, that an increasing debasement of the qualities of the fluid *must* at length disorder the corpuscles.

But one of the chief points we have been arguing for, is the therapeutical relations of inflammation to the fluid of the blood. We have said that suppuration is a means whereby injurious matter is eliminated from the plasma; that granulations and pus may perform the office of a depurating organ vicariously. Now we are saying that chronic suppuration and ulceration will occasion deuteropathy of the plasma, and thereby fever. This seems an incongruity. A little consideration, however, will show that it is only seeming incongruity. Diet sustains life and health only by measure; it is pathological in excess and by deficiency. Heat or temperature contributes to life and health only by measure. Oxygen, an essential constituent of the atmosphere, is an element of health and life only by measure; any great variation from a mean amount is pathogenetic. Too much or too little would equally occasion disturbance of health.

So likewise of the matters we are discussing: the process of repair in the commonest injuries has its pathological as well as its therapeutical aspects. The reaction upon which cure depends may be too much, or too little, or too long about. Granulations may be languid, or indolent, or deficient; or they may luxuriate, and usurp the place of fibrous tissue when fibrous tissue is needed for reparation. And fibrous tissue may hold its ground when osseous tissue is demanded for cure. This is sometimes the case in fractured bones. In ordinary contusions, great swellings appear and disappear. In their appearance, matter from the plasma of the blood must have become stationary in the part. In their disappearance, this matter must have been absorbed again into the blood. There must be, therefore, in these cases, in some way or other, a ready passage for elements from the injured tissue into the fluid of the blood.

Analogously, inflammation, as a depurative reaction in distemperatures of the fluid of the blood, may be hindered and interfered with in various ways. There may be too much or too little of it; and certainly it is very often protracted by the persistence of the blood-distempering causes. If, then, there be a ready passage—to and fro, as it were—between the fluid of the blood and the common tissue, it is not difficult to perceive that interference and hindrances may interrupt, or even reverse, the action in this particular.

The ordinary process of repair, then, has a double aspect; and so, also, has inflammation. And our argument is, that protraction or chronicity in either of them introduces the liability to absorption of spoiled material, and that thus therapeutical reactions may operate retroversely and pathologically upon both parts of the blood; the fluid first, and then the corpuscles.

But, that we may give an outline of the argument as it relates to hectic fever, we take as examples necrosis of bone, gout, and scurvy; and, in contrast with these, scarlet fever.

Necrosis of bone produces inflammation. There are hindrances to the removal of the dead bone; therefore inflammation passes into protracted suppuration and ulceration. These gradually weaken the patient; they disable him from taking exercise; digestion is impaired; and the functions of the depurating organs are disturbed.

This is one source of distemperature of the plasma. Distemperature of the plasma aggravates the existing inflammation; but the antecedent—the dead bone—cannot, in the case we are contemplating, be removed. Therefore disorder must proceed, until at length, from the places of suppuration, morbid matter ebbs back into the circulation; and the plasma, thereby thoroughly disordered, reacts upon and disorders the corpuscles, and hectic fever, more or less, appears. Upon this interpretation of the sequence of events between dead bone and fever, to cure the fever the blood-corpuscles must be relieved from their

disorder; to relieve them, the qualities of the plasma must be improved; to amend the qualities of the plasma, the chronic suppuration must cease; and that chronic suppuration may cease, the dead bone must be taken away. We all know that the effectual removal of the dead bone will cure the fever.

Errors in diet by excess produce distemperature of the plasma. And if the depurating organs, or some of them, fail in removing the distemperature, inflammation arises. In gout, the patient is surrounded with every comfort. The error in diet is most probably one of excess; it can, therefore, be easily interdicted; the antecedent can be readily removed; and, by medicine, the depurating organs can be stimulated to a more active working. For these reasons, distemperature of the plasma is concluded to be simple; its qualities are disordered from manageable sources, which may be attacked and abolished before disorder is communicated to the corpuscles. Inflammation in gout is, therefore, acute, and without fever.

On the other hand, in scurvy, the errors in diet are those of deficiency or unwholesomeness, and are much more difficult to deal with, especially where persons are crowded together in unhealthy localities, or limited to camps or ships. The individuals are poor, or, from other circumstances, cannot command the necessaries of life. Therefore, forms of inflammation, which in the rich are simple and acute, are here (or in the poor) chronic, and pass on to suppuration and ulceration, as in the sailors before mentioned, whose bare legs and feet were bitten by mosquitoes; upon which example we observed, that, because the unwholesome diet and confinement could not be changed, therefore the bitten parts passed into chronic ulcers. And if, in persons thus situated, with forms of chronic ulceration from continued unwholesomeness of diet, or other privations, morbid matter should be continually ebbing back into the circulation from places of chronic ulceration, the elements of fever, from a double debasement of the plasma, would exist; and fever thus arising would obviously be different from fever arising through miasms in the air.

In scarlet fever, it is concluded, from premises which have been argued, that disorder of the blood begins, not with the plasma, but in the corpuscles. The illness commences, not with forms of inflammation, but with symptoms of fever. There has been no error in diet: a miasmatous air has acted on the blood; a specific poison is generated; and the plasma is distempered posteriorly to disorder of the corpuscles. But (here as in small-pox) no natural depurating organ seems adapted for the removal of the poison of scarlet fever from the plasma; therefore, inflammation arises—that is to say, reactions between the plasma and the common tissue. The forms, amount, and duration of inflammation in scarlet fever, indicate the amount and severity of the disorder of the blood.

Without these reactions, the patient would die from a poison shut up in the blood; with them, in their severest forms, there is a battling for life. When a joint has been crushed, death would take place from mortification, were there no reaction; but, this established, the patient is saved from the first and most pressing danger, though afterwards he has to pass the ordeal of inflammation, abscess, suppuration, ulceration, and very probably hectic fever too, as best he can, or suffer amputation for a chance of life. In scarlet fever, to cure the inflammation, the plasma must be freed from poisonous matter; and no more must enter it. That no more may enter it, the corpuscles must cease to generate and excrete a poison. Now, from the course observed in normal cases of an exanthematous fever, we may probably conclude that the corpuscles pass through their disorder in from four to six or eight days. When their disorder has passed, no more poisonous matter is discharged from them into the plasma; and, no more poisonous matter mingling with the plasma, the inflammatory reactions and the natural depurating organs together succeed in restoring the plasma to its natural state; whereupon, the blood regaining its normal constitution, inflammation comes to an end, and the patient is cured. The pathological and therapeutical sequences are the same as in small pox.

In the midst of these therapeutical actions and reactions for the depuration of the blood in fever, it would seem that a depurating organ is sometimes coerced, as it were, to an increased and incongruous working; matter not naturally found in the secretion of the organ appearing in it at the crisis of the fever. In the performance of this enforced duty—the elimination of poisonous matter from the plasma—the parenchymatous elements of the organ may be overtasked and injured. Thus, in scarlet fever, the poison in the blood sometimes occasions parenchymatous disease of the kidneys; and, in such cases, there is evidence also of inflammatory reactions in the common tissue of the organ. This complication may have the same reflex effect upon the blood as chronic ulcerations. Spoiled material from the overburthened kidneys may ebb back into the circulation; and a new blood-distemper may be inaugurated from elements of urine retained in the plasma. Such being the case, there would be present the antecedent of a second or reactionary fever; namely, denteropathy of the plasma—that is to say, distemperature—from disease of the kidneys, superposed upon the remnant of the poison of scarlet fever. And it is in perfect accordance with the argument, that a secondary fever from disease of the kidneys should be more apt to appear as a consequent of the primary fever, where the inflammatory reactions in the skin are too slight or insufficient for the full and effectual discharge of the poison. But it is to be observed, that the second fever is not a relapse or reappearance of

the first; it is another fever of different origin. The first fever was occasioned by an aerial miasm; the second is occasioned by a debasement of the plasma acting injuriously on the corpuscles of the blood.

Let us, in concluding this lecture, give a brief summary of the facts and of the arguments.

In necrosis of bone, the pathological series begins with dead bone. If this cannot be taken away, it ends with fever, from deuteropathy of the plasma disordering the corpuscles of the blood.

In pulmonary consumption, the pathological series begins with tubercles in the lung. There are hindrances and difficulties in their discharge: suppuration is made chronic; and the phenomena end with fever from deuteropathy of the plasma.

In scurvy, the series begins with unwholesomeness or deficiency in diet, or other privations which cannot be changed. Ulcerations arise; and the series may end with fever, from deuteropathy of the plasma.

In these examples—namely, hectic fevers—disorder of the blood-corpuscles is posterior to a debasement of the fluid in which they swim; and forms of inflammation, protracted for longer or shorter periods, precede the fever.

On the other hand, in the contagious primary fevers, the pathological series begins with disorder of the corpuscles. It ends with forms of inflammation; because distemperature of the fluid of the blood is, in these fevers, posterior to disorder of the corpuscles. Thus we interpret the relations of fever to inflammation, and of inflammation to fever, by the difference between the two parts of the blood. The facts are, that sometimes fever precedes inflammation, sometimes forms of inflammation precede fever; because sometimes (from aërial poisons) the corpuscles are disordered before the plasma; and sometimes (from unwholesome diet, privations, and chronic ulcerations) the plasma is disordered before the corpuscles. If you accept these interpretations, the whole subject of repair inflammation, and fever, presents a coherency which is worthy of your attention. Thus:

Mechanical objects injure the common tissue; and the process of repair arises.

Errors in diet disorder the plasma; and inflammation appears.

Miasms in the air affect the corpuscles of blood; and primary fever is the result.

Both the process of repair and inflammation, from hindrances and difficulties, may pass into chronic or protracted forms of suppuration, ulceration, and discharges; whereupon, if spoiled material should enter the circulation, and, by reiteration or quantity, thoroughly debase the plasma, the corpuscles suffer, and fever appears; namely, reactionary, hectic, or a plasma fever.

LECTURE III.

XIV.—Continued Fever.

In the sixth volume of the *Transactions of the Medical and Physical Society of Calcutta*, there is a paper by Mr. Leslie, On the Diseases of Gowhattee, the capital of Lower Assam.

"The poorer inhabitants of the town," says Mr. Leslie, "are badly lodged, clothed, and fed. They sleep on a thin mat, spread upon the ground; their food is chiefly rice, and fever is often introduced by an intractable form of bowel complaint. The disease consists in inflammation and ulceration of the large intestines; and so insidious is it that in many cases emaciation has advanced to a great degree, and ulceration of the colic mucous membrane has taken place, before the patient applies for assistance. In such circumstances, he has no pain, or prominent or urgent complaint to make; scarcely allows he is ill, or has loose stools; he merely feels weak and wastes slowly. But, when fever comes on, the patient wastes rapidly, with thirst, loss of appetite, smooth red tongue, hot skin and frequent pulse. Œdema of the extremities appears, and the disease generally proceeds to a fatal termination amidst the most extreme degree of debility."

Mr. Leslie gives a tabular view of forty-seven fatal cases of the disease, with the appearances on dissection, from which it results that every variety of lesion of the mucous membrane of the colon was observed; from inflammation and purulent secretion, lining the membrane, to abrasion and ulceration, various in extent and depth, or even to mortification.

We contrast this form of fever observed by Mr. Leslie, with fever reported on by Dr. Craigie, which appeared in Edinburgh, in 1834 and 1835. One hundred and seventy-four cases were treated; and of these, in one hundred and twenty-six, or seventy-three per cent., the head was the principal part affected. Of twenty-four examinations, after death, brain affections were found in twenty-two. Speaking of these results, Dr. Craigie says, emphatically:—

"We have had several examples of fatal fever, with lesions of the mucous membrane of the stomach, and sometimes enlargement of the intestinal follicles; but we have almost none of *dothinenteritis*, which have been so commonly observed elsewhere. In the whole of the cases treated by myself, there was only one in which the follicles were so much diseased as to

justify particular importance being attached to it, and in this case the ulcerations observed must have existed prior to the fever."

Dr. Robert Perry, from the year 1831 to 1835, made careful observations in upwards of four thousand cases of fever, in Glasgow. Three hundred necroscopic examinations were made; and he dwells particularly on the necessity of distinguishing true typhus from *dothinenteritis*, or typhoid fever.

"Contagious typhus," he says, "is an exanthematous fever, solely produced by the introduction into the system of a specific poison, generated in the human body. It runs a certain course, which may be modified, but cannot be stopped. It is most contagious when the patient is convalescent, the poison being spread abroad by the desquamation of the cuticle. *Dothinenteritis*, or enlargement of the mucous follicles of the smaller intestine, and enlargement and ulceration of the aggregated glands of the lower third of the ileum, is a disease *per se*; and, though it occurs in combination with contagious typhus, it is a different disease, of different origin. It begins with bowel complaint—sometimes so slight at first as scarcely to attract the patient's attention. Afterwards, fever arises. This disease," Dr. Perry goes on to say, "may exist in every degree of mildness or severity; it has no regular period of termination. The fever may run on for two, three, or four weeks, and terminate in gradual restoration to health without any sensible crisis; or the patient may sink under it from exhaustion, or by hæmorrhage from the bowels; or it may end by some of the ulcers of the aggregated glands of the lower third of the ileum penetrating the coats of the intestine."

It is well known, from various afflicting causes—unwholesomeness and insufficiency of food, cold, wet, fatigue, and exposure—that the British and French armies on the heights before Sebastopol suffered an extraordinary amount of sickness: the British army chiefly in the winter of 1854 and 1855; the French army principally in the winter of 1855 and 1856. The former, numbering twenty three thousand soldiers on its muster roll, had upwards of twelve thousand at one time in hospital; the latter, in January, 1856, had thirteen thousand; in February, twenty-one thousand; and in March, eighteen thousand sick and wounded men, distributed in various hospitals, and in other places that could be hastily obtained for their accommodation and treatment. The chief diseases from which these men suffered were, frost-bites, scurvy, chronic dysentery, diarrhœa, and fevers.

"Contagious typhus, scurvy, dysentery, frost-bites, and hospital gangrene," says Dr. Bryce, speaking of the French hospitals on the Bosphorus, in the winter of 1855 and 1856, "abound; but the first-mentioned disease, by its virulence, extent, and type, is more deadly than all the others taken together." The

very large development of scurvy, and the outbreak of contagious typhus, exhausted the sanitary means of the French at Constantinople; and Dr. Bryce noted with astonishment the crowding and filthiness of the patients, the foulness of the bed and body clothes, the unwholesome and ill-ventilated state of the wards, and the stenches arising from various sources. The picture drawn by this gentleman, from personal observation whilst rendering his valuable services to the sick, is one of the most painful and heartrending to be found in the medical records of camps and hospitals.

"I could have no difficulty," says the Doctor, "in pointing out the fallacy of confounding, under one denomination, *two fevers* essentially distinct in respect of symptoms, course, morbid lesions, and etiology. . . . In the contagious typhus, studied in the French hospitals, as elsewhere, there are present the characteristic maculæ and petechiæ, very distingnishable from the rose-coloured papulæ of typhoid fever. In the former there are absent the abdominal symptoms so prominent and almost pathognomonic of the latter. Equally absent are the anatomic lesions, which constitute the morbid state of typhoid fever, namely, morbid state of the intestinal follicles, mesenteric ganglions, and spleen. . . . The number of surgeons who have fallen as sacrifices to their duty is almost without parallel. Forty-six died from typhus alone; scarcely one escaped an attack. There was fear lest the sick should be left utterly without skilled help. Sisters of charity, clergymen, orderlies, and all whose duties compel them to pass several hours daily in the service of the wards, have been, with few exceptions, attacked. But worse even than this is the deplorable fact that patients, labouring under scurvy and bowel diseases, when their progress to recovery is established, are seized with contagious typhus.

The vast proportion of the patients, the soldiery, showed, by their attenuated limbs and sunken countenance, a by-gone period of privation of proper nutriment; and the resemblance, in external aspect, of these patients to those suffering from fever during the famine years in Ireland, was very striking. On the other hand, "I have seen," says Dr. Bryce, "in the orderlies, and in others attending upon the sick in previous good health, the sudden invasion of typhus, marked by rigors, intense heat, headache, and delirium; and oftentimes the termination was as rapid and unexpected as the onset. These circumstances are very different from the slowness and incertitude of the same nominal state in typhoid fever."

If we note the series or order of events as related by these several observers, it is, in Mr. Leslie's report, poor diet, hardships, bowel complaint, dysentery, emaciation, and lastly, fever. In Dr. Craigie's cases, it was first fever, headache, and then cerebral and pulmonary affection.

Dr. Perry expressly says that he had to treat two fevers; one beginning with bowel complaint, sometimes so slight at first as scarcely to attract the patient's attention; the other was the contagious typhus. In the hospitals at Constantinople, we have the testimony of Dr. Bryce to the same effect. He had no difficulty in pointing out the fallacy of treating, under one denomination, two fevers, distinct in their etiology; the one supervening on previous forms of ill health, on bygone periods of hardship and suffering; the other attacking the orderlies and attendants on the sick—persons in good health and comfortable circumstances until prostrated by fever. The facts place before us two fevers, the one, contagious typhus, striking down the healthy; the other, typhoid fever; and the question, as regards the latter form of fever, is: Whether or not anatomical lesions, from which morbid matter may be absorbed into the blood, exist before the fever, as they do in hectic fever?

Now in the case of the sailors we have before mentioned, the men transacted the duties of the ship with ulcers on their legs. In many other instances, persons walk about with extensive ulcerations on the legs and elsewhere. Persons in consumption pursue their daily avocations with suppuration and ulceration in the lungs. In the cases of fever observed by Mr. Leslie, emaciation was apparent, and ulceration of the colic mucous membrane had taken place before the patient applied for assistance—before symptoms of fever appeared. The history of perforating ulcers of the stomach proves that, in many cases, persons do not complain of illness with ulceration of the mucous membrane of that organ. The anatomical lesion is not known to exist, little or no complaint being made until perforation of the coats of the stomach has occurred. In the case of fever, expressly noted by Dr. Craigie as associated with disease of the mucous membrane of the bowel, he says that the local disease existed before the fever.

In the armies before Sebastopol, thousands of men with scurvy, diarrhœa, and dysentery, faced and did their duty. In the overcrowded and poorest parts of cities and towns, where hardships must be endured, sickness abounds: scrofula, scurvy, diarrhœa, dysentery, typhoid fever, and typhus. Under such circumstances, numerous poor persons certainly continue their avocations, with bowel-complaint, diarrhœa, and chronic dysentery. The person may have no pain, or prominent, or urgent complaint to make, may scarcely allow that he is ill, or has loose stools; he merely feels weak and wastes slowly. Chronic ulcerations are preliminary conditions of hectic fever.

The inference is, that the anatomical lesions of diarrhœa and dysentery exist before; but are sometimes latent, until symptoms of fever appear. The fact cannot be demonstrated, neither can it be denied; and, in the absence of direct proof

to the contrary, collateral circumstances are in favour of the inference. Could it be demonstrated, hectic and typhoid would be essentially the same kind of fever; both occasioned by debasement of the plasma, from absorption of morbid matter through places of chronic ulceration or anatomical lesion. The differences between them would arise from differences in the situation of the anatomical lesions, and from difference in the qualities of the matter absorbed.

If it should be inquired why ulceration of the mucous membrane of the bowel (the ileum, or colon)—anatomical lesions of diarrhœa and dysentery—occasion typhoid, when chronic ulcerations elsewhere in the body occasion hectic fever, we should reply: Because the special function of the part affected gives specialty to the fever. The mucous membrane of the bowel is eminently an absorbing surface. Myriads of groups of cellular bodies naturally exist here, the contents of which are all normally tending inwards, towards the fluid of the blood, which is, indeed, their destination. And Peyer's patches in the small intestine are especially rich in absorbent vessels. Therefore morbid elements, from ulceration of these parts, are the more readily indraughted into the blood. Moreover, excretions of the alimentary canal are naturally offensive; these must mingle with the matter of the ulcerations; and, on that account, spoiled and offensive material, abnormally ebbing back into the circulation from places of ulceration or disease in the mucous membrane of the bowel, will more speedily and thoroughly debase the plasma than from ulcerations elsewhere in the body.

"Typhus fever," says Dr. William Fergusson, "may be called the endemic of the British Isles, and of the same parallels of latitude on the continent of Europe. But, besides the endemic, or aërial, origin of this fever, there appears to be another source of the typhoid poison; I mean that which arises in crowded hospitals, prisons, barracks, and other habitations. I acknowledge it to be unphilosophical and incongruous to imagine that two fevers, springing out of sources so distinct, should yet so entirely resemble each other that they have been treated, classed, and acknowledged for the same; nor can I afford any satisfactory explanation of this phenomenon. But the fact is certain that they do so arise; for in the contagious ulcer, or hospital gangrene, we possess a demonstrable, tangible, and visible proof of its existence. This ulcer is a local form—a visible personification, if I may use the term—of the typhoid poison. It never occurs but under the most distressful crowding of the sick and wounded, and it is then so highly contagious that all other ulcers, or even abrasions of the skin, are speedily involved in its destructive course. The contagion is capable of inducing typhous fever upon the sound, healthy, inmates; but in the wounded, where the poison finds a *nidus* and a vent,

instead of affecting the constitution generally, it commits its ravages upon the wounded limb. So strong is the predisposition to that form of pyrexia, called typhoid, that it is prone to become an aggravation and superaddition to other forms of fever. All the remittent types and degrees, as well as the catarrhal and peripneumonic fevers are apt, when long continued or improperly treated, to glide into it."

Now not only is the typhoid pyrexia thus apt to become, as Dr. Fergusson says, an aggravation to other forms of fever; but also it is apt to appear in cases of large, surgical wounds, in other wounds, and in puerperal women, where there is lesion of the mucous membrane of the womb, and an offensive discharge. And, generally, of anatomical lesions with offensive discharges, the typhoid pyrexia is apt to become an aggravation.

From all the foregoing considerations, we set down the anatomical and casual distinctions between typhoid fever and typhus, as follows:—

TYPHOID FEVER.	TYPHUS.
Previous, and perhaps present, hardships and privations.	No previous hardships.
Chronic lesions of the mucous membrane of the bowel:	No chronic lesion of the mucous membrane of the bowel, or elsewhere.
Absorption of morbid matter from the anatomical lesions; and lastly—	No absorption of morbid matter to change the qualities of the fluid of the blood; but, first—
Fever, or disorder of the corpuscles of the blood, from debasement of the fluid in which they swim.	Fever, or disorder of the blood-corpuscles from an aërial poison introduced through the lungs; the corpuscles of the blood being the first elements of the body disordered.

The points of distinction, as they relate to our argument, being that:—In typhoid fever the blood-corpuscles are disordered in consequence of previous debasement of the fluid in which they swim;—whereas in typhus they are disordered by a poison acting directly on them in their passage through the lungs.

From the contrast above shewn, it is evident that the condition of the patient is more complicated in typhoid fever than in typhus; for in a given case of each fever, the consequences of the fever may be the same, or equal; but the previous anatomical lesions, which occasion typhoid fever, introduce a most material element as respects the history, treatment, and termination of that form of continued fever.

But it has been concluded that disease of the blood-corpuscles may generate a contagious virus. In the inoculated small-pox, in the case of the physician before related, and in other contagious fevers, the quantity of morbid matter introduced into the blood is exceedingly small; but the magnitude of the effect is very great. The reason we have assigned is because the morbid matter disorders by contagion, or by a contact-action, the whole of the corpuscles of the blood. There are no reasons for excluding, in any arbitrary manner, a similar contact-action amongst the blood-corpuscles from morbid matter introduced into the blood through anatomical lesions in the bowel; especially in cases where the matter absorbed may happen to be particularly offensive; therefore, a severe form of typhoid fever may introduce the virus or poison of typhus.

We say it may do so; because, although the history of hectic fever shows that it is not every form of reactionary fever that gives origin to a contagious virus, still, inasmuch as the generation of a contagious virus in the blood and symptoms of fever go together, so, on the other hand, we apprehend we are justified in saying that the graver forms of typhoid fever do, or may, issue in the production of a contagious matter; thereby, persons in health—attendants on the sick—are struck down with fever; a fever, be it observed—in the persons who may have been attacked by fever in this way—of very different beginnings from the fever of the person communicating it; occasioned, not through debasement of the fluid of the blood from preexisting anatomical lesions, but through a virus generated in the blood of the first patient, and attacking the second and healthy person through the lungs.

The history or sequence of the sickness which abounds in times of hardship or famine, substantiates the argument; for the order usually is:—first, forms of inflammation without fever, ulcerations, boils, and eruptions; then follow bowel-complaints, chronic dysentery, and diarrhœa; and, lastly, fevers—the typhoid and typhus. This sequence obtains, because hardships in diet disorder the bowels; and this disorder is comprised in the terms diarrhœa and dysentery. The anatomical lesions of chronic diarrhœa and dysentery occasion typhoid fever; and typhoid fever may beget the poison of typhus. Our own experience accords with the conclusion that the typhoid poison will sometimes beget fever in the healthy attendants on the sick.

Let us examine how far the facts observed in puerperal fever bear out the validity of our argument in this respect.

XV.—Puerperal Fever.

Gestation and parturition are physiological acts; but the condition of the puerperal woman, immediately after her delivery, is one of a *quasi* pathological character in the following respects:—

The blood abounds in plasma elements, and forms, on withdrawal by venesection, a buffed coat. The uterus, just relieved of its contents, may be likened to an injured organ proceeding to recovery. The condition of its blood-vessels is one favourable to the ebbing back of morbid matter into the circulation, and there are offensive discharges from the uterus. Cruveilhier has seized this analogy in its minutest details. Dr. Ferguson too, dwells upon it. "The puerperal woman," he says, "is in a condition analogous to that of a person who has undergone a serious surgical operation. All the uterine vessels from which the placenta has been detached, form part of a large wound, and are bathed in the secretions which take place while this wound is healing." Such being the conditions of the puerperal woman, her medical treatment has become a matter of routine for the first three days, lest a chill, an emotion, or an error in diet, should change reparative reactions into forms of inflammation. And the words of Mr. Hunter, which we quoted in our first lecture, are applicable here. "Granulations may all at once fade away and lose their life; and pus of a very different quality is discharged when granulations are fading away, than when a sore is granulating freely."

The analogy, or rather perfect similarity, between the condition of the womb in the puerperal woman, when, from a chill, an emotion, an error in diet, or any other accident, granulations have all at once lost their life, and the condition of the mucous membrane of the bowel in cases of chronic dysentery, as respects their both being sources of specially offensive matter, can scarcely be denied; and if it be not denied, then the same course of reasoning which has been employed in tracing the relation between ulceration of the mucous membrane of the bowel and typhoid fever, and between typhoid fever and typhus, is equally available in explanation of the relation of inflammation of the womb in the puerperal woman, to two forms of puerperal fever. That is to say:—In the puerperal woman the conditions upon which inflammation of the womb supervenes are favourable to a debasement of the plasma, because there are anatomical lesions, and because, from the state of the uterine vessels, morbid matter is specially liable to ebb back into the circulation; and should this absorption take place to a degree sufficient to disorder the corpuscles of the blood, symptoms of fever, from deuteropathy of the plasma, would arise; that is, fever, from the same kind of antecedents as hectic and typhoid fever. But it has been concluded that disorder of the

blood-corpuscles may issue in the generation of a contagious poison; consequeutly, in a lying-iu hospital, a puerperal woman, in an adjoining bed, or in an adjacent ward, may become affected with fever from the illness of the first patient;—a fever, be it observed, in this second case, of very different beginnings from the first; occasioued, not through anatomical lesions and debasement of the plasma; but by a poisou generated in the body of the first patient; affecting the second woman from the air and through the lungs.

On referring to the literature of puerperal fever, it is seeu that physicians have beeu divided in their views conceruing the pathology of that disease; some holding the opinion that puerperal fever is an idiopathic fever; others regarding it as a local inflammation, taking the form of peritonitis, metritis, or uteriue phlebitis. These two views, there seems to us no necessity for placing in antagonism. In all cases of puerperal fever there are forms of inflammation and fever; but, if there be truth in our doctrine of fever, it is of the utmost importauce in any given case of puerperal fever, to determine whether inflammation has, or has not, preceded, and beeu a cause of fever. If it has, the fever is a reactionary, or plasma fever, *i.e.*, fever from debasement of the plasma, aud anatomical lesions precede the fever; if it has uot, the fever is a primary or aërial fever, aud indepeudent of any inflammation or anatomical lesion, except what may follow from it.

Upon the subject discussed in this section, it has been suggested that we have offered no proof of the existence of *granulations* in the interior of the puerperal womb. But, as we have said in the first lecture, granulations are simple cellular growths; their shape and colour are not essential to their definitiou; and certainly "the large wound from which the placenta has been detached" can heal only through the intervention of uew cellular growths, which may, from uusuitable conditions, "all at once lose their life and fade away;" aud should they do so, then reparative reactions are changed to forms of inflammation —a granulating wound is "all at once" changed into an ulcerative one.

XVII.—Crisis, Protraction, and Relapse: Fever.

There are no diseases in which the transitiou from unfavourable to favourable symptoms is more marked than in primary coutagious fevers. Thus, in typhus, in the great majority of those who recover, the turn in favour of the patient is determined within a period of tweuty-four hours. In our exposition of fever, we have treated the corpuscles of the blood as living bodies. And in all phenomena depending on the actions of living bodies there are epochs or periods; there is a time of

germination, maturity, and decliue. And symptoms of fever, because they are based upon au independent actiou or metamorphosis of the blood-corpuscles, have also their analogous epochs.

When the fluid of the blood is disordered short of affecting the corpuscles, and some form of inflammation arises for its depuration, there is but one preternatural depurative reaction: namely, that of the fluid upon the common tissue, denoted by the inflammation. But in fever there are two preternatural reactions: one, and the first, that of the corpuscles, whereby they extricate themselves from a virus; or, in other words, excrete a poison, and transfer it to the fluid in which they swim: the other, and subsequent one, that of the fluid whereby the virus is handed over to the common tissue for expulsion by some form of inflammation. In both kinds of inflammation, namely, those without fever, and those consequent on fever, the inflammation has reference, not to the state of the corpuscles, but to the state of the fluid of the blood.

The crisis, or maturity and termination of fever, then, depends on two events, both of them vital actions: *first*, the discharge of the virus from the corpuscles; and *secondly*, its discharge from the plasma. If there be obstacles to the discharge of the virus from the corpuscles, symptoms of fever will be protracted; should there be hindrances to its discharge from the plasma, forms of inflammation will be protracted.

If the corpuscles have freed themselves from the virus, but there are hindrauces to its discharge from the plasma, then the imperfectly depurated fluid may react upon the convalescing corpuscles, and symptoms of fever be renewed. And the more probable will be this renewal, or relapse, where inflammation is acting the part of a depurativo organ. But let it be observed in the circumstances presumed, the fever into which the patient relapses has a different *condition précédente* from the fever with which he was first attacked. The first fever has an aërial origin, the second, or prolonged fever, is due to imperfect depuration of the plasma. Let us examine this point in more detail.

When causes of hardship and sickness abound in the mixed population of a crowded city, complex forms of illness must often occur. These it is very difficult to unravel, because the persons are not, or have not been, continuously under medical observation. We therefore again refer to the crew of a ship, where, from the inmates being seen daily, and from other circumstances, the sequence of events can be better followed.

Formerly, in long voyages, it has not unfrequently happened that a salt diet, bad water, and confinement on board the ship, have produced in the men that state of blood which founds, upon the slightest local provocation, chronic ulcerations on the exterior of the body. Also, in addition to the exterior ulcerations,

various forms of bowel complaint, diarrhœa, and chronic dysentery, have been present. With the crew in these conditions, the ship has sailed into an unhealthy port, and some of the men have taken fever from the poisonous atmosphere of the shore. Here fever has arisen from the aërial source; but the symptoms, history, and termination of the fever will vary greatly in the different men; because the anatomical conditions in which they severally are when they enter upon fever are different. And when the aërial fever has run its course, or when its proper epoch of termination has arrived, we have seen men linger in fever, or seem to fall back—relapse—into fever. The reason is because the latent anatomical lesions, present before the aërial fever set in, have now, from the commotion of that fever, themselves become influential by giving indraught to morbid matter into the blood; in creating, not a continuation of the aërial fever, but another—the typhoid pyrexia, or fever. In such cases the patient no doubt relapses into fever; but he does not relapse into the same fever; it is into another and a different one.

"During seven months in 1831, eleven hundred and forty-five cases of fever were treated by me," says Dr. Perry, "to a termination. Of this number there were nineteen relapses, averaging ono in sixty; and I was particularly struck with the fact that these relapses, almost altogether occurred in patients who had been admitted in hospital on account of some local inflammatory affection; and who had caught fever in the house, or who were seized with it shortly after leaving the house. The incorrectness of calling *these* cases of relapse, is quite manifest, as it was an entirely new disease. It is as absurd to talk of a relapse of typhus fever as to talk of a relapse of small-pox, scarlet fever, or measles. When an increase of fever takes place after the crisis of typhus, it is owing to some other disease."

Renewed accessions of fever after the crisis of typhus are regarded by Dr. Perry, and we think correctly, as analogous to renewed accessions of fever, after the crisis of scarlet fever, from disease of the kidneys, or from anatomical lesion in any other important organ. And generally, respecting the contagious fevers—scarlet fever, measles, small-pox, and typhus—it may be concluded of persons lingering in fever much beyond the natural periods of these fevers, that the fever of the latter part of the period is not the fever of the first part of it. It is thus, we apprehend, that persons are not unfrequently said to have scarlet fever and typhus. That is to say, more correctly, the typhoid pyrexia, from some anatomical lesion giving inlet to morbid matter to the blood, may follow close upon the primary fever. And it is not difficult to understand that an aërial fever may, through anatomical lesions occasioned by that

fever, *glide* into typhoid fever without any interval by whic the term relapse is made appropriate.

Thus fevers may interchange, or the one may be supplanted by the other. For persons may be approaching, or have just entered the state of typhoid fever, when an aërial poison introduces and substitutes the dominating typhus. On the other hand, persons recovering from the aërial fever, typhus or scarlet fever, may, through anatomical lesions, lapse into typhoid fever; but for fevers thus to glide, or relapse, into one another, the *conditions précédentes* of both fevers must have been present.

"Great numbers of the sick," says Dr. Bryce, "admitted into hospital with scurvy, dysentery, and diarrhœa, were approaching, or had already symptoms of typhoid fever; when, upon being crowded together with others suffering from the true contagious typhus, that disease dominated all the rest." Our interpretation of the fact noticed by Dr. Bryce, is that irritation, or disorder of the corpuscles of the blood—denoted by symptoms of fever—arises from debasement of the plasma; but that, when an aëriform poison of specific qualities reaches them, in their passage through the lungs, a contagious abnormal metamorphosis of the corpuscles is substituted in place of simple irritation. Also, in contagious fever, when the abnormal metamorphosis of the corpuscles has run its course, irritation of the corpuscles may continue, if anatomical lesions, giving inlet to morbid matter, remain.

Hectic and typhoid fevers are, then, both of the reactionary class; for both arise from debasement of the plasma through absorption of morbid matter from anatomical lesions. But the site of the lesion and the quality of the matter absorbed, occasion important differences in the history and symptoms of the two fevers. Then, again, of the two fevers in puerperal women, the one is a reactionary or plasma fever; the other is a primary or specific fever.

It results then, that anatomical lesions, giving inlet to morbid matter to the blood, exist prior to the appearance of the typhoid pyrexia, or typhoid fever; the quality of the matter absorbed distinguishing this pyrexia from hectic fever. Contagious typhus belongs to a different class of fevers. Nevertheless, the typhoid pyrexia may introduce the poison of typhus. The order of events then may be as follows:—Hardships in diet, diarrhœa, the anatomical lesions of diarrhœa giving inlet to morbid matter to the blood, typhoid pyrexia, typhoid pyrexia generating the virus of a primary fever. On the other hand, the order may be:—Aërial miasms, primary contagious fever, an anatomical lesion occasioned by that fever giving inlet to morbid matter to the blood, typhoid pyrexia.

We here give a tabulated view of these results, with the following explanation:—

Primary and generally aërial.	Specific and infectious.	Small-pox, scarlet fever, measles, typhus, etc.	Corpuscles of the blood diseased *before* distemperature of the plasma.
Reactionary or plasma fevers.	Hectic and non-infectious.	From diseased joints or bones, pulmonary consumption, and other chronic anatomical lesions, with bland discharges.	Corpuscles of the blood disordered or diseased in *consequence* of debasement of the plasma.
	Typhoid and mixed.	From anatomical lesions of the mucous membrano of the bowel; of the puerperal womb; from surgical wounds aud other anatomical lesions, with fœtid and ichorous discharges.	

In this table, the first column exhibits two classes of fever: and the last column shews how we consider them dependent upon the physical constitution of the blood, and upon properties usually assigned by physiologists to the corpuscles.

Injurious substances dissolved in the air and inhaled by the luugs, and specific poisons introduced iu very small quautity into the blood, produce infectious or *contagious fevcrs.* A contagious virus is generated in the blood ; and forms of inflammation follow upon the fever. The examples in this country are small-pox, scarlet fever, measles, and typhus. In these fevers, it is the *quality* and not the *quantity* of the poison which is operative. For the quantity, as in the inoculated poisons, may be *exceedingly small ;* but its effects are great, by reason of some indepeudent action excited by it in the blood itself. This independent action, which extends through the whole mass of the blood, is, we say, the result of a contagion, contact-action, or fermentation amongst the blood-corpuscles ; an *abnormal metamorphosis* which issues in the generation of a contagious virus. And the phenomena, because dependeut on the vital action of cellular bodies—the blood-corpuscles—have therefore *a crisis*, a more or less decided or marked epoch of rise, maturity, and decline. The risc, crisis, and decline of

contagious fevers corroborates the conclusion which bases phenomena of fever upon the vital actions of cellular bodies.

Spoiled materials constantly ebbing back into the plasma from chronic anatomical lesions with *bland discharges*—such as diseased joints, protracted suppurations, pulmonary consumption, etc.—distemper the fluid of the blood; and reiterated or deuteropathic distemperature of the fluid disorders the corpuscles and produces *hectic fevers*. In these fevers, there is no evidence of that kind of independent action in the blood which issues in the generation of a contagious virus. They are non-infectious; therefore there is an absence of proof of any specific quality in the matter introduced into the blood. Hectic fevers, moreover, have no marked epochs of maturity and decline; and that the symptoms of fever depend upon the constancy and reiteration of the spoiled material seems proved; because they continue whilst the source of absorption continues, but disappear when it is removed, as it often can be, by amputation or by some other surgical operation. Hectic fever, then, depends on the permanence of the source of spoiled material; on a continuousness of absorption which debases the fluid, and, through the fluid, the corpuscles of the blood. Symptoms of fever follow from their disorder; but this disorder—if we may so speak—is one of constant fretting and irritation, from the constancy of the ebbing back of spoiled matter into the plasma. There is no independent action in the blood, such as issues in the generation of a contagious virus. Pathogenetical substances, then, introduced into the blood, occasion fever; by their quality, when a very small amount excites an independent action in the blood-corpuscles, which has its rise, maturity, and decline, and issues in the generation of an infectious virus; by quantity and reiteration, when continuousness of introduction occasions constancy of irritation amongst the corpuscles, denoted by hectic and non-infectious forms of fever, which decline and disappear when the source of morbid absorption is removed.

Interposed, as it were, between these two fevers—contagious and hectic—are *typhoid fevers*, or *typhoid pyrexiæ*. These sometimes have the characters of the contagious, sometimes of hectic fever; because the forms and symptoms which these typhoid fevers may assume are determined sometimes by the quality, and sometimes by the constancy or reiteration of the morbid matter. In proportion as the quality is more offensive or specific—as when the source of absorption is hospital gangrene, ulceration of the mucous coat of the bowel, a surgical wound with an ichorous discharge, or the puerperal womb—the fever approaches in all its phenomena to the contagious forms of fever. On the other hand, the more the symptoms of fever depend upon reiteration of the morbid matter, as when the source of absorption is an anatomical lesion with a more

bland discharge, then the more the phenomena observed in the patient approach to those of hectic fever.

There is no arbitrary assnmption here, in arguing differences in the symptoms and phenomena of reactionary fevers from differences in tho quality of the matter absorbed into the plasma of the blood from different conditions of anatomical lesions, or different states of ulceration. The fact of difference of quality in the matters discharged is demonstrated in surgical nlcers, some of which discharge a bland and laudable pus, others a thin, irritative, and fœtid ichor. Nay, the same anatomical lesion or ulceration will differ in the quality of tho matter discharged—and therefore in the quality of the matter which may be absorbed—on two consecntive days. It results, then, that if the corpuscles of the blood take on a general and independent action from a poison which may come into contact with only a few of them, an infectious or contagious virus is generated in tho blood, and infectious or *contagious forms of fever* appear: whereas, if the corpuscles of blood suffer only constant irritation or fretting from the continuousness of the presence of an irritating matter in the plasma, a contagious virus is not generated, but *non-infectious* or *hectic* forms of fever arise. The contagious or primary, and the reactionary or hectic, are tho two classes of fever which we conclude to be dependent upon the physical constitution of the blood. In the one class, the corpuscles aro disordered, irrespectively of the fluid in which they swim. In the other class, debasement of the fluid is antecedent to disorder in the corpnscles. But the two parts of the blood are much too closely associated with each other, for impairment of the quality of one part to continue without impairment of the qualities of the other part. Therefore fever of the one class may glide or relapse into fever of the other class. And it would seem, from the physiology of the corpuscles, that contagious fevers from aërial poisons must relapse into fever from debasement of the plasma, were it not so ordered that forms of inflammation perform the office of a depurating organ. The corpuscles of the blood generate the contagious virus, and they transfer it to the plasma; and should the specific form of inflammation characterising the fever fail of fixing it in the common tissue, symptoms of fever are renewed.

The same poisonons atmosphere may bo breathed for the same time by a number of persons, and it will produce fever only in a few of them; because the corpuscles of the blood have different degrees of resistance in different persons. A poison in the atmosphere is a *condition précédente*; it is not the logical *antecedent* of contagious fever. Some physiological element of the body must be disturbed, or must be interposed between the aërial poison and symptoms of fever. This physi-

ological element we have concluded to be the corpuscles of the blood.

In like manner, it is not every distemperature of the fluid of the blood that occasions hectic fever. On the contrary, the first effect of simple distemperature of the fluid of the blood is to occasion new, or to aggravate existing forms of inflammation. It is only when the cause of the dyscrasy of the fluid is permanent and has overcome the resistance of the corpuscles, that symptoms of hectic fever appear. Anatomical lesions (ulceration and suppuration) have therefore only the same relation to hectic fever, that poisons in the air have to contagious fever. They are *conditions précédentes*, and not the antecedents of the fever. Extensive ulcerations and suppurations exist without hectic fever, because the anatomical lesions must have become continuous inlets of spoiled material to the blood, and the fluid of the blood must be thereby contiuuously debased before symptoms of hectic fever appear.

It has not unfrequently happened that persons in dissecting the dead body or in necroscopic inspections have pricked their finger; of such many escape without inconveuience, whilst mother, more unfortunate, may be attacked with fever; and recover only after extensive inflammations and more than one large critical abscess. The reason is because the puncture, or anatomical lesion, is only a *eondition précédente*. A contagious disorder amongst the blood-corpuscles is the proper antecedent of fever; aud distemperature of the fluid of the blood is the proper antecedent of inflammation and critical discharge. Fever from the puncture, therefore, does not arise unless the blood-corpuscles be affected.

So, again, anatomical lesiou, or follicular disease of the mucous membrane of the bowel, is a *eondition précédente*, and not the *anteeedent* of typhoid fever. A great number of persons may be suffering hardships, and may be afflicted with chronic dysentery and diarrhœa, or with follicular disease of the mucous membraue of the bowel; but only a very few of them may fall into typhoid fever; and these may not be those with the worst, or most extensive anatomical lesions. The reason is because the state of fever does not depend upon the anatomical lesions in the manner of an antecedent. Symptoms of fever make their appearance only when the lesions are giving inlet to morbid matter into the blood, which, either by quality, or frequency of iteration, disorders or irritates the blood-corpuscles.

It will be observed of this exposition that the *condition précédente* of fever, occasioned through miasms in the atmosphere, is external to, and apart from the body. A poison from the air affects the blood (the corpuscles) and fever is actually the first phenomenon of departure from health; whereas in reactionary fevers the *eondition précédente* is within, or is a part of the

body. Some anatomical lesion, and an irritative matter in the plasma, exist before, or are preliminary to symptoms of fever. A departure from the standard of health has therefore already occurred before; but, perhaps, without symptoms until the typhoid pyrexia appears.

In bringing our discourse upon a very difficult and interesting subject to an end, we have only in conclusion to observe that the doctrine of fever we have propounded is based on the physiological and physical constitution of the blood; on the known properties of cellular bodies; and on microscopical examinations of the state of the plasma and blood-vessels in the process of repair and inflammation. The chief points of the doctrine are:—

The fluid of the blood has a pathology distinct from that of the corpuscles.

Forms of inflammation, or of local poisoning without fever, make their appearance when there is dyscrasy of the fluid only: forms of fever when the corpuscles are disordered.

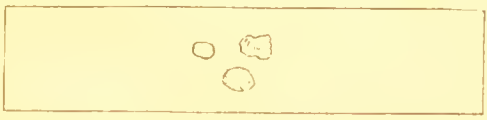
These points are submitted to your learned judgment and impartial criticism, as propositions; though, to our mind, they assume the aspect of truths, derived, as they are, from years of experiment and research upon the qualities of blood, and of the elements of repair and inflammation.

Upon the whole subject, the ideas we have endeavoured to express are, that numerous and various substances may circulate through the body dissolved in the fluid of the blood; and that the cellular elements of the body (including the corpuscles of the blood) have various affinities, and oppose various degrees of resistance to injurious matter. Therefore, if from distemperature of the fluid the common tissue be first disturbed, forms of inflammation first arise; if some local parenchyma be disturbed, the phenomena are those of local poisoning, delirium, coma, diuresis, purging, sweating, salivation, etc.; if the corpuscles of the blood be first disordered, fever is the result.

APPENDIX.

Experiment II, mentioned in our second lecture, refers to appearances of such a novel and remarkable kind, that we think the details, upon which success in repeating it depends, should be given:—

A glass tube, one-tenth of an inch in bore, drawn out to a point, is used for a pipette. Dissolve two grains of common salt and one grain of carbonate of soda in half an ounce of water. This forms a solution which may or not be used with sherry wine. Take a slip of glass, and receive on it a drop of fresh blood. Place, by means of the pipette, beside the blood, but not touching it, a drop of the saline solution and a drop of sherry wine, thus:—



Let fall a thin piece of glass upon the fluids and they will mingle in various proportions. A good eighth object glass is required; we use a middle eye-piece; and it is essential, to see the tails, etc., that the edge or circumference of the mixed fluids should be looked at, and not the middle of the mass. We have made the experiment, with and without the saline solution, numberless times; and though never failing to produce tailed forms in some part or other of the mixed fluids, still we find it impossible to foretell what set of appearances will prevail *within* the corpuscles. Some one or other of the following forms will, however, be seen. Half an hour or more should be given for the best effects.

The way in which the wine and the saline solution take off all disposition of the corpuscles to adhere in rolls; the various prickly appearances which some of them assume; and the innumerable very different markings seen in the interior of others, are scarcely of less interest than the tails. Opinions may vary as to the nature of the motions seen in the tails. If there be motion in the fluid, the tails are of course influenced by it; nevertheless, there is a constant wavy movement, which seems independent of all motion in the fluid.

Where the undiluted wine has acted upon the corpuscles, they are entirely deprived of their colouring matter, and a

minute molecular matter floats in the surrounding fluid without molecular motion; but, where the wine is acting and producing tails, numerous and variously sized molecules are thrown off from the corpuscles; and these all have an intense molecular movement. The change which the fluid undergoes in consequence is well worthy of especial notice.

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